DOCUMENT RESUME

ED 168 813 SE 025 983

TITLE	What Should Be the Energy Policy of the United States? National Debate Topic for High Schools, 1978-1979. Senate, 95th Congress, 2d Session.
INSTITUTION	Library of Congress, Washington, D.C. Congressional Research Service.
PUB DATE	78
NOTE	526p.; Not available in hard copy due to small type
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 052-071-00567-6; No price quoted)
EDRS PRICE	MF02 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Civics; *Debate; *Energy; Federal Government; Government Role; Natural Resources; *Policy Formation; Reference Materials; Science Education; *Secondary Education; Social Problems; Social Studies; *World Problems
IDENTIFIERS	Energy Education

ABSTRACT

This collection of excerpts and bibliographies address the three debate propositions selected as subjects of the 1978-1979 debate question for high schools selected by the National University Extension Service, "What should be the energy policy of the United States?" The collection is divided into three parts each addressing one of the debate propositions: (1) Resolved, that the Federal Government should exclusively control the development and distribution of energy resources in the United States; (2) Resolved, that the Federal Government should establish a comprehensive program to significantly reduce energy consumption in the United States; and (3) Resolved, that the Federal Government should establish a comprehensive program to significantly increase the energy independence of the United States. An introductory section summarizes the U.S. policy response to the energy dilemma. The materials are intended not as an exhaustive coverage of the subject, but to furnish debators with a basis for further research on the topic. (RE)

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Senate / 95th Congress / 2d Session / Document No. 95-116

What Should Be the Energy Policy of the United States?

National Debate Topic for High Schools
1978-1979

Pursuant to Public Law 88-246

Compiled by the Congressional Research Service
Library of Congress

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1978
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PUBLIC LAW 88-246, 88TH CONGRESS, S. 2311, DECEMBER 30, 1963

AN ACT To provide for the preparation and printing of compilation of materials relating to annual national high school and college debate topics

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Librarian of Congress is authorized and directed to prepare compilations of pertinent excerpts, bibilographical references, and other appropriate materials relating to (1) the subject selected annually by the National University Extension Association as the national high school debate topics and (2) the subject selected annually by the American Speech Association as the national college debate topic. In preparing such compilations the Librarian shall include materials which in his judgment are representative of, and give equal emphasis to, the opposing points of view on the respective topics.

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Approved December 30, 1963.

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FOREWORD

The 1978–79 debate question for high schools selected by the National University Extension Service is "What should be the energy policy of the United States?" Under this general heading, the three debate propositions are:

Resolved, That the Federal Government should exclusively control the development and distribution of energy resources in the United States.

Resolved, That the Federal Government should establish a comprehensive program to significantly reduce energy comsumption in the United States.

Resolved, That the Federal Government should establish a comprehensive program to significantly increase the energy independence of the United States.

The following excerpts and bibliography are divided into three parts relating to each of the three proposed topics plus an introductory part, summarizing the national policy response to the energy dilemma. These materials are not intended to provide exhaustive coverage of the subject, but only to furnish debaters with a start on their own work. While the excerpts and references have been chosen to represent a range of views and a variety of approaches to the problems raised by these topics, their inclusion does not imply any kind of approval or disapproval, or of recommendation of line of argumentation by the Congressional Research Service.

Robert L. Bamberger, analyst in energy policy, and Adrienne C. Grenfell, research librarian, with the assistance of Duane A. Thompson, analyst in energy policy in the Environment and Natural Resources Policy Division compiled the materials in the document. Bibliographic annotations, where included, were prepared by the Library Services Division.

All of the U.S. Government documents referred to in the bibliography may be found in most U.S. Government depository libraries. Information as to the location of the nearest depository library may be obtained from local public libraries. Copies will not be available for distribution by the Library of Congress.

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GILBERT GUDE,
Director, Congressional Research Service

PART ONE

THE ENERGY DILEMMA: THE NATIONAL POLICY RESPONSE

OVERVIEW*

The diagnosis of the U.S. energy crisis is quite simple: demand for energy is increasing, while supplies of oil and natural gas are diminishing. Unless the U.S. makes a timely adustment before world oil becomes very scarce and very expensive in the 1980's, the nation's economic security and the American way of life will be gravely endangered. The steps the U.S. must take now are small compared to the drastic measures that will be needed if the U.S. does nothing until it is too late.

How did this crisis come about?

Partly it came about through lack of foresight. Americans have become accustomed to abundant, cheap energy. During the decades of the 1950's and 1960's, the real price of energy in the U.S. fell 28 percent. And from 1950 until the quadrupling of world oil prices in 1973–1974, U.S. consumption of energy increased at an average annual rate of 3.5 percent. As a result of the availability of cheap energy, the U.S. developed a stock of capital goods—such as homes, cars, and factory equipment—that uses energy inefficiently.

The Nature of the Problem

The most critical increase in demand has been for oil, the most versatile and widely used energy resource. To meet that growing demand, the U.S. has turned increasingly to imports. In January and February of 1977, the U.S. imported about 9 million barrels of oil per day, half of total domestic oil consumption. By 1985, U.S. oil consumption could equal 12 to 16 million barrels per day.

U.S. domestic oil production has been declining since 1970. New production from Alaska, the deep Outer Continental Shelf, and new recovery methods should reverse the decline, but will be unable to satisfy the projected growth in U.S. demand. Other major additions to domestic oil supply are unlikely.

The principal oil-exporting countries will not be able to satisfy all the increases in demand expected to occur in the U.S. and other countries throughout the 1980's. In 1976, the 13 OPEC countries exported 29 million barrels of oil per day. If world demand continues to grow at the rates of recent years, by 1985 it could reach or exceed 50 million barrels per day. However, many OPEC countries cannot significantly expand production; and, in some, production will actually decline.

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*From The National Energy Plan, Executive Office of the President, Energy Office and Planning, April 1977, p. vii–xiv, 25–33, xv–xxiii.

Thus, as a practical matter, overall OPEC production could approach the expected level of world demand only if Saudi Arabia greatly increased its oil production. Even if Saudi Arabia did so, the highest levels of OPEC production probably would be inadequate to meet increasing world demand beyond the late 1980's or early 1990's.

There are physical and economic limits on the world's supply of oil. A widely used geological estimate of total recoverable world oil resources, past and present, is about 2 trillion barrels. More than 360 billion barrels have already been consumed. Current proved crude reserves are 600 billion barrels. World consumption of oil has grown at an average annual rate of 6.6 percent since 1940, and it grew by as much as 8 percent annually during the 1960's.

If it could be assumed that world demand for oil would grow at an annual rate of only 3 percent, and if it were possible (which it is not) that production would keep pace with that rate of growth, the world's presently estimated recoverable oil resources would be exhausted before 2020. At a conjectural growth rate of 5 percent, those resources would be exhausted by 2010. Despite some uncertainty about the exact size of recoverable world oil resources, and about the rate of increase of productive capacity, this fundamental fact is clear: *within about four generations, the bulk of the world's supply of oil, created over hundreds of millions of years, will have been substantially consumed.*

Of course, actual physical exhaustion of oil resources will not occur. Even today, well over half the oil in existing fields is being left in the ground because additional recovery would be too expensive. As production by conventional methods declines and oil becomes more scarce, its price will rise and more expensive recovery methods and novel technologies will be used to produce additional oil. As this process continues, the price of oil will become prohibitive for most energy uses. Eventually the nations of the world will have to seek substitutes for oil as an energy source, and oil will have to be reserved for petrochemical and other uses in which it has maximum value.

The world now consumes about 20 billion barrels of oil per year. To maintain even that rate of consumption and keep reserves intact, *the world would have to discover another Kuwait or Iran roughly every three years, or another Texas or Alaska roughly every six months.* Although some large discoveries will be made, a continuous series of such finds is unlikely. Indeed, recent experience suggests that, compared to world oil consumption, future discoveries will be small or moderate in size, will occur in frontier areas, and will yield oil only at very high cost. Obviously, continued *high rates of growth* of oil consumption simply cannot be sustained.

Natural gas supplies are also limited. In the U.S., natural gas constitutes only 4 percent of conventional energy reserves, but supplies 27 percent of energy consumption. Gas consumption grew about 5.7 percent per year between 1960 and 1970. From 1970 to 1974, however, consumption dropped 1.3 percent. The demand for gas is considerably higher than the amount that can be supplied. Hence, gas is rationed by prohibitions on hook-ups for new homes in many areas.

Gas is not only in short supply, but its allocation across the country is distorted, and its distribution among end-uses is unsatisfactory.

Federal regulation of the wellhead price of natural gas in interstate commerce has discouraged its distribution from gas producing States to other States, and has encouraged consumption of this premium fuel for less essential uses. Industry and utilities currently consume almost 60 percent of U.S. natural gas, despite the fact that other fuels could be used in a majority of cases.

During the 1973–75 period, only 19 percent of new gas reserve additions were made available to the interstate market, and much of that gas was from the Federal domain. Since the price of intrastate gas is not regulated, there are strong economic incentives to sell gas within the producing States. *The existing distinction between intrastate and interstate sales has given intrastate users first claim to natural gas.*

Strategies and Objectives

The U.S. has three overriding energy objectives:

as an immediate objective that will become even more important in the future, to reduce dependence on foreign oil and vulnerability to supply interruptions;

in the medium term, to keep U.S. imports sufficiently low to weather the period when world oil production approaches its capacity limitation; and

in the long term, to have renewable and essentially inexhaustible sources of energy for sustained economic growth.

The U.S. and the world are at the early stage of an energy transition. Previous energy transitions in the U.S. were stimulated by new technologies, such as the development of the railroad and the mass production of automobiles, which fostered the use of coal and oil, respectively. The latest transition springs from the need to adjust to scarcity and higher prices.

To make the new transition, the U.S. should adhere to basic principles that establish a sound context for energy policy and provide its main guidelines. The energy crisis must be addressed comprehensively by the Government and by a public that understands its seriousness and is willing to make necessary sacrifices. Economic growth with high levels of employment and production must be maintained. National policies for the protection of the environment must be continued. Above all, the U.S. must solve its energy problems in a manner that is fair to all regions, sectors, and income groups.

The salient features of the National Energy Plan are:

conservation and fuel efficiency;

rational pricing and production policies;

reasonable certainty and stability in Government policies;

substitution of abundant energy resources for those in short supply; and

development of nonconventional technologies for the future.

Conservation and fuel efficiency are the cornerstone of the proposed National Energy Plan. Conservation is cheaper than production of new supplies, and is the most effective means for protection of the environment. It can contribute to international stability by moderating the growing pressure on world oil reserves. Conservation and improved efficiency can lead to quick results. For example, a significant percentage of poorly insulated homes in the United States could be brought up to strict fuel-efficiency standards in less time than it now takes to design, build, and license one nuclear powerplant.

Although conservation measures are inexpensive and clean compared with energy production and use, they do sometimes involve sacrifice and are not always easy to implement. If automobiles are to be made lighter and less powerful, the American people must accept sacrifices in comfort and horsepower. If industry is required to make energy-saving investments and to pay taxes for the use of scarce resources, there will be some increases in the cost of consumer products. These sacrifices, however, need not result in major changes in the American way of life or in reduced standards of living. Automobile fuel efficiency can be greatly improved through better design and use of materials, as well as by producing lighter and less powerful cars, without inhibiting Americans' ability to travel. With improved energy efficiency, the impact of rising energy prices can be significantly moderated.

Energy conservation, properly implemented, is fully compatible with economic growth, the development of new industries, and the creation of new jobs for American workers. Energy consumption need not be reduced in absolute terms; what is necessary is a slowing down in its rate of growth. By making adjustments in energy consumption now, the U.S. can avoid a possibly severe economic recession in the mid 1980's.

The U.S. has a clear choice. If a conservation program begins now, it can be carried out in a rational and orderly manner over a period of years. It can be moderate in scope, and can apply primarily to capital goods, such as homes and automobiles. If, however, conservation is delayed until world oil production approaches its capacity limitation, it will have to be carried out hastily under emergency conditions.

It will be sudden, and drastic in scope; and because there will not be time to wait for incremental changes in capital stock, conservation measures will have to cut much more deeply into patterns of behavior, disrupt the flow of goods and services, and reduce standards of living.

Pricing policies should encourage proper responses in both the consumption and the production of energy, without creating any windfall profits. *If users pay yesterday's prices for tomorrow's energy, U.S. resources will be rapidly exhausted. If producers were to receive tomorrow's prices for yesterday's discoveries, there would be an inequitable transfer of income from the American people to the producers, whose profits would be excessive and would bear little relation to actual economic contribution.*

Currently, Federal pricing policy encourages overconsumption of the scarcest fuels by artificially holding down prices. If, for example, the cost of expensive foreign oil is averaged with cheaper domestic oil, consumers overuse oil, and oil imports are subsidized and encouraged. Consumers are thus misled into believing that they can continue to obtain additional quantities of oil at less than its replacement cost.

Artificially low prices for some energy sources also distort interfuel competition. The artifically low price of natural gas, for example, has encouraged its use by industry and electric utilities, which could use coal, and in many areas has made gas unavailable for new households, which could make better use of its premium qualities.

These misguided Government policies must be changed. But neither Government policy nor market incentives can improve on nature and create additional oil or gas in the ground. From a long-term perspective, prices are an important influence on production and use. As long as energy consumers are misled into believing they can obtain energy cheaply, they will consume energy at a rate the U.S. cannot afford to sustain. Their continued overuse will make the nation's inevitable transition more drastic and difficult.

A national energy policy should encourage production. The energy industries need adequate incentives to develop *new* resources and are entitled to sufficient profits for exploration for *new* discoveries. But they should not be allowed to reap large windfall profits as a result of circumstances unrelated to the marketplace or their risk-taking.

The fourfold increase in world oil prices in 1973–74 and the policies of the oil-exporting countries should not be permitted to create unjustified profits for domestic producers at consumer's expense. By raising the world price of oil, the oil-exporting countries have increased the value of American oil in existing wells. That increase in value has not resulted from free market forces or from any risk-taking by U.S. producers. *National energy policy should capture the increase in oil value for the American people.* The distribution of the proceeds of higher prices among domestic producers and consumers must be equitable and economicaly efficient if the United States is to spread the cost fairly across the population and achieve its energy goals.

The pricing of oil and natural gas should reflect the economic fact that the true value of a depleting resource is the cost of replacing it. An effective pricing system would provide the price incentives that producers of oil and natural gas need by focusing on harder to find new supplies. The system should also moderate the adjustment that households will have to make to rising fuel costs. It should end the distortions of the intrastate-interstate distinction for new natural gas, which is a national resource. It should also promote conservation by raising the ultimate price of products made by energy-intensive processes.

Reasonable certainty and stability in Government policies are needed to enable consumers and producers of energy to make investment decisions. A comprehensive national energy plan should resolve a wide range of uncertainties that have impeded the orderly development of energy policy and projects. Some uncertainties are inherent in a market economy, and Government should not shelter industry from the normal risks of doing business. But Government should provide business and the public with a clear and consistent statement of its own policies, rules, and intentions so that intelligent private investment decisions can be made.

Resources in plentiful supply should be used more widely as part of a process of moderating use of those in short supply. Although coal comprises 90 percent of United States total fossil fuel reserves, the United States meets only 18 percent of its energy needs from coal. Seventy-five percent of energy needs are met by oil and natural gas although they account for less than 8 percent of U.S. reserves. This imbalance between reserves and consumption should be corrected by shifting industrial and utility consumption from oil and gas to coal and other abundant energy sources.

As industrial firms and utilities reduce their use of oil and gas, they will have to turn to coal and other fuels. The choices now for electric utilities are basically coal and nuclear power. Expanding future use of coal will depend in large part on the introduction of new technologies that permit it to be burned in an environmentally acceptable manner, in both power plants and factories. Efforts should also be made to develop and perfect processes for making gas from coal.

Light-water nuclear reactors, subject to strict regulation, can assist in meeting the United States energy deficit. The 63 nuclear plants operating today provide approximately 10 percent of U.S. electricity, about 3 percent of total energy output. That contribution could be significantly increased. The currently projected growth rate of nuclear energy is substantially below prior expectations due mainly to the recent drop in demand for electricity, labor problems, equipment delays, health and safety problems, lack of a publicly accepted waste disposal program, and concern over nuclear proliferation. The Government should ensure that risks from nuclear power are kept as low as humanly possible, and should also establish the framework for resolving problems and removing unnecessary delays in the nuclear licensing process.

To the extent that electricity is substituted for oil and gas, the total amounts of energy used in the country will be somewhat larger due to the inherent inefficiency of electricity generation and distribution. But conserving scarce oil and natural gas is far more important than saving coal.

Finally, *the use of nonconventional sources of energy must be vigorously expanded.* Relatively clean and inexhaustible sources of energy offer a hopeful prospect of supplementing conventional energy sources in this century and becoming major sources of energy in the next. Some of these nonconventional technologies permit decentralized production, and thus provide alternatives to large, central systems. Traditional forecasts of energy use assume that nonconventional resources, such as solar and geothermal energy, will play only a minor role in the United States energy future. Unless positive and creative actions are taken by Government and the private sector, these forecasts will become self-fulfilling prophecies. Other technologies that increase the efficiency of energy use should also be encouraged, such as cogeneration, the simultaneous production of industrial process steam and electricity.

A national energy plan cannot anticipate technological miracles, Even so, nonconventional technologies are not mere curiosities. Steady technological progress is likely, breakthroughs are possible, and the estimated potential of nonconventional energy sources can be expected to improve. Some nonconventional technologies are already being used, and with encouragement their use will grow. Because nonconventional energy sources have great promise, the Government should take all reasonable steps to foster and develop them.

The National Energy Plan is based on this conceptual approach. It contains a practical blend of economic incentives and disincentives as well as some regulatory measures. It strives to keep Government intrusion into the lives of American citizens to a minimum. It would return the fiscal surpluses of higher energy taxes to the American people.

Finally, the Plan sets forth goals for 1985 which, although ambitious, can be achieved with the willing cooperation of the American people. These goals are:

Reduce the annual growth of total energy demand to below 2 percent;

Reduce gasoline consumption 10 percent below its current level;

Reduce oil imports from a potential level of 16 million barrels per day to 6 million, roughly one-eighth of total energy consumption;

Establish a Strategic Petroleum Reserve of 1 billion barrels;

Increase coal production by two-thirds, to more than 1 billion tons per year;

Bring 90 percent of existing American homes and all new buildings up to minimum energy efficiency standards; and

Use solar energy in more than 2½ million homes.

The Plan would reverse the recent trend of ever-rising oil imports and ever-increasing American dependence on uncertain foreign sources of supply. It would prepare the United States for the time when the world faces a limitation on oil production capacity and consequent skyrocketing oil prices. It would achieve substantial energy savings through conservation and increased fuel efficiency, with minimal disruption to the economy, and would stimulate the use of coal in a manner consistent with environmental protection.

The United States is at a turning point. It can choose, through piecemeal programs and policies, to continue the current state of drift. That course would require no hard decisions, no immediate sacrifices, and no adjustment to the new energy realities. That course may, for the moment, seem attractive. But, with each passing day, the United States falls farther behind in solving its energy problems. Consequently, its economic and foreign policy position weakens, its options dwindle, and the ultimate transition to scarce oil supplies and much higher oil prices becomes more difficult. If the United States faces up to the energy problem now and adopts the National Energy Plan, it will have the precious opportunity to make effective use of time and resources before world oil production reaches its capacity limitation.

The energy crisis presents a challenge to the American people. If they respond with understanding, maturity, imagination, and their traditional ingenuity, the challenge will be met. Even the "sacrifices" involved in conservation will have their immediate rewards in lower fuel bills and the sense of accomplishment that comes with achieving higher efficiency. By preparing now for the energy situation of the 1980's, the U.S. will not merely avoid a future time of adversity. It will ensure that the coming years will be among the most creative and constructive in American history.

* * * * * * *

CHAPTER III.—PRINCIPLES AND STRATEGY OF THE NATIONAL ENERGY PLAN

Broad public understanding of the gravity of the energy problem, a commitment to action, and a willingness to endure some sacrifice are all indispensable to the success of a national energy plan. In the present circumstances, an energy plan that demanded nothing from the American people would be no energy plan at all, but merely a prescription for chaos at a later date.

Changes in energy demand and supply have long leadtimes, and, therefore, the coming energy transition cannot be made overnight. For the transition to be made without serious economic and social disruptions, it will have to take place over a period of years. If the United States is to be prepared for the time when world oil production approaches its capacity limitation and then begins to level off, it must take action now.

The ultimate question is whether this society is willing to exercise the internal discipline to select and pursue a coherent set of policies well in advance of a threatened disaster. Western democracies have demonstrated such discipline in the past in reacting to immediate, palpable threats to survival, as in time of war. But they have had less success in harnessing their human and material resources to deal with less visible and immediate threats to their political and economic systems. When dangers appear incrementally and the day of reckoning seems far in the future, democratic political leaders have been reluctant to take decisive and perhaps unpopular action. But such action will be required to meet the energy crisis. If the nation continues to drift, it will do so in an increasingly perilous sea.

PRINCIPLES

The principles set forth in this chapter provide a framework not only for present policies, but also for development of future policies. Planning is necessarily an ongoing process. The National Energy Plan will have to be adjusted continually as new experience and knowledge are gained, as government programs take effect, as new technologies develop, and as the world's political and economic circumstances change.

The following 10 principles divide into two groups. The first five establish the context in which energy policy must be formulated. The remaining five are fundamental to the proposed comprehensive National Energy Plan.

The first principle is that the energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively, and by a public that understands its seriousness and is ready to make necessary sacrifices. The declining availability of oil and natural gas will affect virtually all energy prices and consumption patterns in the United States, for the various energy supplies are all part of an integrated energy market. Therefore, in this democratic society, a solution can be found only in comprehensive Government policy-making informed by public comment and supported by public understanding and action.

The Federal Government can pass laws and encourage action. State and local governments can play active roles. But this society can function at its best only when citizens voluntarily work together toward a commonly accepted goal. Washington can and must lead, but the nation's real energy policy will be made in every city, town and village in the country.

The second principle is that healthy economic growth must continue. It is an axiom of public policy that full employment be promoted. The energy problem can be solved without turning off or slowing down America's economic progress. In developing energy policy, measures should be designed to minimize adverse economic and fiscal consequences by returning to the economy funds collected to carry out energy policy. National energy policy can move toward economic rationality while protecting jobs, avoiding rampant inflation, and maintaining economic growth. Conservation initiatives, for example, not only contribute to productivity, but also create a large number of new jobs. Indeed, in the long run, the nation can continue to enjoy economic health only if it solves its energy problems.

The third principle is that national policies for the protection of the environment must be maintained. Energy policy should sustain and improve the quality of life of the American people. It would be ironic if, in moving toward that objective, the nation unnecessarily degraded the quality of the environment and made this country and the planet a less healthful place in which to live.

Virtually every available source of energy has its disadvantages. Storage and combustion of hydrocarbons can pollute the air. Oil imports and drilling on the Outer Continental Shelf present a risk of spills. Strip mining of coal scars the landscape, and deep mining causes deaths through accidents and black lung disease; coal combustion also presents risks to health; liquefied natural gas poses safety problems, as do light-water nuclear reactors. In energy planning, it is necessary to recognize hazards and risks and to reduce them to relatively low levels.

In the long run, there is no insurmountable conflict between the twin objectives of meeting energy needs and protecting the quality of the environment. The energy crisis and environmental pollution both arose from wasteful use of resources and economic and social policies based on the assumption of unlimited and cheap resources. The solutions to many energy and environmental problems follow a parallel course of improving efficiency and harnessing waste for productive purposes.

The fourth principle is that the United States must reduce its vulnerability to potentially devastating supply interruptions. Although conserving energy in general is an important goal, conserving oil has an even higher priority. Continued high vulnerability to interruptions of foreign oil supply is unacceptable.

Considerations of national security, as well as the problem of funding ever-increasing balance of payments deficits, suggest rejection of any "solution" to the energy problem through unrestrained growth of oil imports. Continued growth of imports would erode the nation's economic security, promote dissension with allies, and jeopardize America's world leadership. Moreover, the time is approaching when world oil production will no longer be able to supply the United States with increasing levels of imports.

The solution to the problem of vulnerability does not lie in a crash program of production to achieve energy independence. There is no justification for massive, reckless development of all U.S. energy resources, depletion of critical domestic oil and gas reserves, pollution of the environment, draconian conservation measures, and rejection of the substantial economic benefits of oil imports, all in the name of energy independence.

An appropriate and far more sensible goal is relative invulnerability. The United States should be prepared to import foreign oil for a number of years because it is an available source of supply that does not deplete domestic resources. Through effective conservation and increased use of abundant domestic resources such as coal, oil imports can be reduced to a manageable level. A large Strategic Petroleum Reserve, diversification of foreign sources of oil, and contingency plans should help to deter interruptions of foreign oil supply and protect the economy should an interruption occur.

The fifth principle is that the United States must solve its energy problems in a manner that is equitable to all regions, sectors, and income groups. No segment of the population should bear an unfair share of the total burden, and none should reap undue benefits from the nation's energy problems. In particular, the elderly, the poor, and those on fixed incomes should be protected from disproportionately adverse effects on their income. Energy is as necessary to life as food and shelter.

The energy industries need adequate incentives to develop new resources and are entitled to sufficient profits to encourage exploration and development of new finds. But they should not be allowed to reap large windfall profits as a result of circumstances not associated with either the marketplace or their risk-taking. The fourfold increase in world oil prices in 1973–74 and the policies of the oil-exporting countries should not be permitted to create unjustified profits for domestic producers at consumers' expense. By raising the world price of oil, the oil-exporting countries have increased the value of American oil in existing wells. National energy policy should capture that increase in value for the American people. However, where incentives are legitimately needed to stimulate new production, energy policy should allow adequate returns to producers. The distribution of the proceeds of higher prices among domestic producers and consumers must be equitable and economically efficient if the nation is to spread the costs fairly across the population and meet its energy goals.

Some regions of the country, particularly the Gulf Coast States and Appalachia, are large energy producers. Other regions, such as the Rocky Mountain and Great Plains States, have large energy resources which have not yet been extensively developed. And still other regions, such as New England and California, import most of their energy from other regions and other nations. The Plan must assure that policies are equitable across the country, and that the special needs of each region are met. Prices for energy should be reasonably uniform to prevent economic dislocations and unjustified variations in consumer costs.

The environmental quality of producing States and States with untapped resources should be protected by strict standards effectively enforced. Producing States should be fairly compensated, and consuming States should be assured a fair share of energy supplies at reasonable prices.

The Federal Government can enact national policies to further these goals, and can recognize that the States also have important responsibilities for the formulation and execution of energy policy. But States within the various regions must also accept their share of the responsibility for national equity if the U.S. is to avoid "energy Balkanization." It would be desirable for States to develop energy policies that complement the Plan while meeting local and regional needs.

The sixth principle, and the cornerstone of National Energy Policy, is that the growth of energy demand must be restrained through conservation and improved energy efficiency. Conservation and improvement in energy efficiency is the most practical course of action for the United States and for the nations of the world. Conservation is cheaper than production of new energy supplies, and is the most effective means for protection of the environment.

Conservation and improved efficiency can lead to quick results. A significant percentage of poorly insulated homes in the United States could be brought up to strict fuel efficiency standards in less time than it now takes to design, license, and build one nuclear powerplant.

Although conservation measures are inexpensive and clean compared with energy production, they do involve sacrifice and are sometimes difficult to implement. If automobiles are to be made lighter and less powerful, the American people must accept some sacrifice in comfort and horsepower. If industry is required to make energy-saving investments and to pay taxes on the use of scarce fuels, there will be some increases in the cost of consumer products. These sacrifices, however, need not result in major changes in the American way of life or in a reduced standard of living. Automobile fuel efficiency can be greatly improved through better design of cars, and thus gasoline consumption could be significantly reduced without inhibiting Americans' ability to travel. With improved energy efficiency, the impact of rising energy prices can be significantly moderated. Energy conservation, properly implemented, is fully compatible with economic growth, the development of new industries, and the creation of new jobs for American workers. Energy consumption need not be reduced in absolute terms; what is necessary is a slowing down in its rate of growth.

If a conservation program is instituted now, it can be carried out in a rational and orderly manner over a period of several years. It can be moderate in scope, and can apply primarily to capital goods, such as homes, automobiles, factories, equipment, and appliances. If, however, conservation is delayed until world oil production approaches its capacity limitation, it will have to be carried out hastily under emergency conditions. It will then be drastic; and, because there will not be time to wait for incremental changes in capital stock, conservation measures will have to cut much more deeply into patterns of behavior, disrupt the flow of goods and services, and reduce standards of living.

Finally, conservation in America can contribute to international stability by moderating the growing pressure on world oil resources. Indeed, reduction of America's demand for world oil would be a form of assistance to the developing countries.

The seventh principle underlying the National Energy Plan is that energy prices should generally reflect the true replacement cost of energy. Energy prices should move toward a level that reflects the true value of energy in order for market signals to work in harmony with conservation policy. When the cost of expensive foreign oil is averaged with cheaper domestic oil, consumers overuse oil. Government policy that promotes overuse by artificially holding down prices misleads consumers into believing that they can continue to obtain additional quantities of oil at less than its replacement cost.

Artificially low prices for particular energy sources also distort interfuel competition. The artificially low price of natural gas, for example, has encouraged its use by industry and electric utilities, which could use coal, and has made gas unavailable for new households, which could make better use of its premium qualities.

Neither Government policy nor market incentives can create additional oil or gas in the ground. But from a long-term perspective, prices are an important influence on production and use. As long as energy consumers are enticed into believing that they can continue to pay yesterday's prices for tomorrow's energy, they will continue to use more energy than the nation can really afford, U.S. resources will be rapidly exhausted, and continued overuse will make the inevitable transition more sudden and difficult.

Although producers need incentives for exploration and new development, pricing policies should not give them windfall profits unrelated to their economic contribution. If producers were to receive tomorrow's prices for yesterday's discoveries, there would be an inequitable transfer of income from the American people to the oil and gas producers, and producers' profits would be excessive.

The eighth principle is that both energy producers and consumers are entitled to reasonable certainty as to Government policy. An inadequately organized Federal Government, conflicting signals from different Federal agencies, and unwieldy and confusing regulatory procedures have resulted in major bottlenecks in the development of energy resources. The Plan should resolve a wide range of uncertainties that have impeded the orderly development of energy policy and projects. Some uncertainties are inherent in a market economy, and Government cannot and should not shelter industry from the normal risks of doing business. But Government can and should provide business and the public with a clear and consistent statement of its own policies, rules, and intentions, so that intelligent private investment decisions can be made. In order to be able to provide certainty and consistency in energy policy-making, the Federal energy agencies should be organized into a Department of Energy.

The ninth principle is that resources in plentiful supply must be used more widely, and the nation must begin the process of moderating its use of those in short supply. Although coal comprises 90 percent of domestic fossil fuel reserves, the United States meets only 18 percent of its energy needs from coal. Seventy-five percent of energy needs are met by oil and natural gas although they account for less than 8 percent of U.S. reserves. This imbalance between reserves and consumption should be corrected by shifting from oil and gas to coal and other domestic energy sources.

If the United States is to preserve its scarce reserves of oil and gas and still reduce the growth of imports, policies must be forged to reduce consumption of oil and gas, particularly by automobiles, industry, and electric utilities. As industry reduces its use of oil and gas, it will have to turn to coal and other fuels. The choices for electric utilities for the foreseeable future will be coal and nuclear power.

Expanding future use of coal will depend in large part on the introduction of new technologies that permit it to be burned in an environmentally acceptable manner, in both power plants and factories, for electricity, for process steam, and for heat. Efforts must also be made to perfect processes for low Btu gasification of coal and to develop new technologies for advanced high Btu gasification.

Light-water nuclear reactors, subject to strict regulation, can assist in meeting the nation's total net energy deficit. The 63 nuclear plants operating today provide approximately 10 percent of U.S. electricity, about 3 percent of total energy consumed. That contribution could be significantly increased. The currently projected growth rate of nuclear energy is substantially below prior expectations due mainly to the recent drop in demand for electricity, labor problems, equipment delays, health and safety problems, lack of a publicly accepted waste disposal program, and concern over nuclear proliferation. The Government should ensure that risks from nuclear power are kept as low as possible, and should also resolve problems and unnecessary delays in the nuclear licensing process.

To the extent that electricity from coal is substituted for oil and gas, the total amounts of energy used in the country will be somewhat larger due to the inherent inefficiency of electricity generation and distribution. But conserving scarce oil and natural gas is more important than saving coal.

The tenth principle is that the use of nonconventional sources of energy must be vigorously expanded. Relatively clean and inexhaustible sources of energy are a hopeful prospect, as supplements to conventional energy resources in this century, and as major sources of energy in the next. Many of these sources permit decentralized production, and thus provide alternatives to large, central systems. Traditional forecasts of energy use assume that nonconventional resources, such as solar and geothermal energy, will play only a minor role in the energy future. Unless positive and creative actions are taken by Government and the private sector, these forecasts will become self-fulfilling prophecies. Other technologies that increase efficiency of energy use, such as cogeneration of industrial process steam and electricity, should also be encouraged.

The Plan should not be premised on technological miracles. But nonconventional technologies are not mere curiosities. Steady technological progress is likely, breakthroughs are possible, and the estimated potential of nonconventional energy sources can be expected to improve. Many nonconventional technologies are already being used, and with encouragement their use will grow. Because nonconventional energy sources have great promise, the Government should take all reasonable steps to foster and develop them.

THE BROAD PERSPECTIVE

The U.S. has three overriding energy objectives. As an immediate objective, which will become even more important in the future, the U.S. must reduce its dependence on foreign oil to limit its vulnerability to supply interruptions. In the medium term, the U.S. must weather the stringency in world oil supply that will be caused by limitations on productive capacities. In the long term, the U.S. must have renewable and essentially inexhaustible sources of energy for sustained economic growth. The strategy of the Plan contains three major components to achieve these objectives.

First, by carrying out an effective conservation program in all sectors of energy use, through reform of utility rate structures, and by making energy prices reflect true replacement costs, the nation should reduce the annual rate of growth of demand to less than 2 percent. That reduction would help achieve both the immediate and the medium-term goals. It would reduce vulnerability and prepare the nation's stock of capital goods for the time when world oil production will approach capacity limitations.

Second, industries and utilities using oil and natural gas should convert to coal and other abundant fuels. Substitution of other fuels for oil and gas would reduce imports and make gas more widely available for household use. An effective conversion program would thus contribute to meeting both the immediate and the medium-term goals.

Third, the nation should pursue a vigorous research and development program to provide renewable and other resources to meet U.S. energy needs in the next century. The Federal Government should support a variety of energy alternatives in their early stages, and continue support through the development and demonstration stage for technologies that are technically, economically, and environmentally most promising.

The Plan seeks to achieve the overriding objectives by other means as well. To reduce vulnerability, the Strategic Petroleum Reserve should be expanded, foreign sources of oil should be diversified, and contingency plans should be put in place. To help weather the approaching capacity limitations on world oil production, incentives should be provided to encourage new production in Alaska, on the Outer Continental Shelf, and from advanced recovery techniques. Potential new sources of gas hold great promise and should be developed. Conversion from oil and gas to coal should be facilitated by development of more environmentally acceptable methods for using coal.

The 10 principles of the National Energy Plan provide a realistic framework for these actions. By pursuing conservation, bringing energy prices into line with replacement costs, and expanding the use of coal, the U.S. can reduce oil imports to an acceptable level and prepare for the coming stringency in oil supplies. Backed by a large Strategic Petroleum Reserve, a more diversified set of foreign oil suppliers, and contingency plans, the United States can reduce its vulnerability to supply interruptions to an acceptable level. Measures can be designed to assure that American workers, the poor, and the elderly do not suffer as a result of rising prices. Economic growth can be promoted and inflationary pressures kept within bounds. Regional and environmental imbalances can be recognized and corrected with maximum equity. And nonconventional sources of energy can be promoted to meet long-term needs.

The United States is at a turning point. It can choose, through piecemeal programs and policies, to continue the current state of drift. That course would require no hard decisions, no immediate sacrifices, and no adjustment to the new energy realities. That course may, for the moment, seem attractive. But, with each passing day, the nation falls farther behind in solving its energy problems. Consequently, its economic and foreign policy position weakens, its options dwindle, and the ultimate transition to stringency in oil supplies and higher oil prices becomes more difficult.

An alternative to continued drift is the comprehensive National Energy Plan.

* * * * * * *

SUMMARY OF THE NATIONAL ENERGY PLAN

Conservation

In the transportation sector, the Plan proposes the following major initiatives to reduce demand:

a graduated excise tax on new automobiles with fuel efficiency below the fleet average levels required under current legislation; the taxes would be returned through rebates on automobiles that meet or do better than the required fleet averages and through rebates on all electric automobiles;

a standby gasoline tax, to take effect if total national gasoline consumption exceeds stated annual targets; the tax would begin at 5 cents per gallon, and could rise to 50 cents per gallon in 10 years if targets were repeatedly exceeded by large or increasing amounts; the tax would decrease if a target were met; taxes collected would be returned to the public through the income tax system and transfer payment programs; States would be compensated for lost gasoline tax revenues through sources such as the Highway Trust Fund;

fuel efficiency standards and a graduated excise tax and rebate system for light-duty trucks;

removal of the Federal excise tax on intercity buses;

increase in excise tax for general aviation fuel, and elimination of the existing Federal excise tax preference for motorboat fuel;

improvement in the fuel efficiency of the Federal automobile fleet, and initiation of a vanpooling program for Federal employees.

To reduce waste of energy in existing buildings, the Plan proposes a major program containing the following elements:

a tax credit of 25 percent of the first $800 and 15 percent of the next $1,400 spent on approved residential conservation measures;

a requirement that regulated utilities offer their residential customers a "turnkey" insulation service, with payment to be made through monthly bills; other fuel supplies would be encouraged to offer a similar service;

facilitating residential conservation loans through opening of a secondary market for such loans;

increased funding for the current weatherization program for low-income households;

a rural home conservation loan program;

a 10 percent tax credit (in addition to the existing investment tax credit) for business investments in approved conservation measures;

a Federal grant program to assist public and non-profit schools and hospitals to insulate their buildings;

inclusion of conservation measures for State and local government buildings in the Local Public Works Program.

The development of mandatory energy efficiency standards for new buildings will be accelerated. In addition, the Federal Government will undertake a major program to increase the efficiency of its own buildings.

The Plan proposes the establishment of mandatory minimum energy efficiency standards for major appliances, such as furnaces, air conditioners, water heaters, and refrigerators.

The Plan proposes to remove major institutional barriers to cogeneration, the simultaneous production of process steam and electricity by industrial firms or utilities, and to provide an additional 10 percent tax credit for investment in cogeneration equipment. Encouragement will also be given to district heating, and the Energy Research and Development Administration (ERDA) will undertake a study to determine the feasibility of a district heating demonstration program at its own facilities.

To promote further industrial conservation and improvements in industrial fuel efficiency, an additional 10 percent tax credit for energy-saving investments would be available for certain types of equipment (including equipment for use of solar energy) as well as conservation retrofits of buildings.

The Plan also contains a program for utility reform, with the following elements:

a phasing out of promotional, declining block, and other electric utility rates that do not reflect cost incidence; declining block rates for natural gas would also be phased out;

a requirement that electric utilities either offer daily off-peak rates to customers willing to pay metering costs or provide a direct load management system;

a requirement that electric utilities offer customers interruptible service at reduced rates;

a prohibition of master metering in most new structures;

a prohibition of discrimination by electric utilities against solar and other renewable energy sources;

Federal authority to require additional reforms of gas utility rates;

Federal Power Commission (FPC) authority to require interconnections and power pooling between utilities even if they are not now subject to FPC jurisdiction, and to require wheeling [third party transmission].

Oil and Natural Gas

Government policy should provide for prices that encourage development of new fields and a more rational pattern of distribution; but it should also prevent windfall profits. It should promote conservation by confronting oil and gas users with more realistic prices, particularly for those sectors of the economy where changes can be made without hardship. To promote these ends, the Plan proposes a new system for pricing oil and natural gas.

The proposal for oil pricing contains the following major elements:

price controls would be extended;

newly discovered oil would be allowed to rise over a 3 year period to the 1977 world price, adjusted to keep pace with the domestic price level; thereafter, the price of newly discovered oil would be adjusted for domestic price increases;

the incentive price for "new oil" would be applicable to oil produced from an onshore well more than 2½ miles from an existing well, or from a well more than 1,000 feet deeper than any existing well within a 2½ mile radius; the incentive price would be applicable to oil from Federal offshore leases issued after April 20, 1977;

the current $5.25 and $11.28 price ceilings for previously discovered oil would be allowed to rise at the rate of domestic price increases;

stripper wells and incremental tertiary recovery from old fields would receive the world price;

all domestic oil would become subject in three stages to a crude oil equalization tax equal to the difference between its controlled domestic price and the world oil price; the tax would increase with the world price, except that authority would exist to discontinue an increase if the world price rose significantly faster than the general level of domestic prices;

net revenues from the tax would be entirely returned to the economy: residential consumers of fuel oil would receive a dollar-for-dollar rebate, and the remaining funds would be returned to individuals through the income tax system and transfer payment programs;

once the wellhead tax is fully in effect, the entitlements program would be terminated, along with certain related activities, but would be retained on a standby basis.

The proposal for natural gas pricing contains the following major provisions:

all new gas sold anywhere in the country from new reservoirs would be subject to a price limitation at the Btu equivalent of the average refiner acquisition cost (before tax) of all domestic crude oil;

that price limitation would be approximately $1.75 per thousand cubic feet (Mcf) at the beginning of 1978; the interstate-intrastate distinction would disappear for new gas;

new gas would be defined by the same standards used to define new oil;

currently flowing natural gas would be guaranteed price certainty at current levels, with adjustments to reflect domestic price increases;

authority would exist to establish higher incentive pricing levels for specific categories of high-cost gas, for example, from deep drilling, geopressurized zones and tight formations;

gas made available at the expiration of existing interstate contracts or by production from existing reservoirs in excess of contracted volumes would qualify for a price no higher than the current $1.42 per Mcf ceiling; gas made available under the same circumstances from existing intrastate production would qualify for the same price as new gas;

the cost of the more expensive new gas would be allocated initially to industrial rather than residential or commercial users;

Federal jurisdiction would be extended to certain synthetic natural gas facilities;

taxes would be levied on industrial and utility users of oil and natural gas to encourage conservation and conversion to coal or other energy sources.

The Plan contains the following additional proposals for oil and natural gas:

to encourage full development of the oil resources of Alaska, Alaskan oil from existing wells would be subject to the $11.28 upper tier wellhead price and would be treated as uncontrolled oil for purposes of the entitlements program; new Alaskan oil finds would be subject to the new oil wellhead price;

production from Elk Hills Naval Petroleum Reserve would be limited to a ready reserve level at least until the west-to-east transportation systems for moving the surplus Alaskan oil are in place or until California refineries have completed a major retrofit program to enable more Alaskan oil to be used in California;

the Outer Continental Shelf Lands Act would be amended to require a more flexible leasing program using bidding systems that enhance competition, to assure a fair return to the public, and to assure full development of the OCS resources;

shale oil will be entitled to the world oil price;

the guidelines established by the Energy Resources Council in the previous administration would be replaced by a more flexible policy: projects for importation of liquified natural gas (LNG) should be analyzed on a case-by-case basis with respect to the reliability of the selling country, the degree of American dependence the project would create, the safety conditions associated with any specific installation and all costs involved; imported LNG would not be concentrated in any one region; new LNG tanker docks would be prohibited in densely populated areas;

Federal programs for development of gas from geopressurized zones and Devonian shale would be expanded;

the Administration hopes to eliminate gasoline price controls and allocation regulations next fall; to maintain competition among marketers, it supports legislation similar to the pending "dealer day in court" bill;

as part of the extension of oil and natural gas price controls, the Administration would urge that independent producers receive the same tax treatment of intangible drilling costs as their corporate competitiors;

a Presidential Commission will study and make recommendations concerning the national energy transportation system.

To provide relative invulnerability from another interruption of foreign oil supply, the Strategic Petroleum Reserve will be expanded to 1 billion barrels; efforts will be made to diversify sources of oil imports; contingency plans will be transmitted to the Congress; and development of additional contingency plans will be accelerated.

Coal

Conversion by industry and utilities to coal and other fuels would be encouraged by taxes on the use of oil and natural gas.

The Plan also contains a strong regulatory program that would prohibit all new utility and industrial boilers from burning oil or natural gas, except under extraordinary conditions. Authority would also exist to prohibit the burning of oil or gas in new facilities other than boilers. Existing facilities with coal-burning capability would generally be prohibited from burning oil and gas. Permits would be required for any conversion to oil or gas rather than to coal. By 1990, virtually no utilities would be permitted to burn natural gas.

While promoting greater use of coal, the Administration will seek to achieve continued improvement in environmental quality. A strong, but consistent and certain, environmental policy can provide the confidence industry needs to make investments in energy facilities. The Administration's policy would:

require installation of the best available control technology in all new coal-fired plants, including those that burn low sulfur coal;

protect areas where the air is still clean from significant deterioration;

encourage States to classify lands to protect against significant deterioration within 3 years after enactment of Clean Air Act amendments;

require Governors to announce intent to change the classification of allowable air quality for a given area within 120 days after an application is made to construct a new source in that area;

require States to approve or disapprove the application within 1 year thereafter.

Further study is needed of the Environmental Protection Agency's policies allowing offsetting pollution trade-offs for new installations. A committee will study the health effects of increased coal production and use, and the environmental constraints on coal mining and on the construction of new coal-burning facilities. A study will also be made of the long-term effects of carbon dioxide from coal and other hydrocarbons on the atmosphere.

The Administration supports uniform national strip mining legislation.

An expansion is proposed for the Government's coal research and development program. The highest immediate priority is development of more effective and economic methods to meet air pollution control standards. The program will include research on:

air pollution control systems;
fluidized bed combustion systems;
coal cleaning systems;
solvent refined coal processes;
low Btu gasification processes;
advanced high Btu gasification processes;
synthetic liquids technology;
coal mining technology.

Nuclear Power

It is the President's policy to defer any U.S. commitment to advanced nuclear technologies that are based on the use of plutonium while the United States seeks a better approach to the next generation of nuclear power than is provided by plutonium recycle and the plutonium breeder. The U.S. will defer indefinitely commercial reprocessing and recycling of plutonium. The President has proposed to reduce the funding for the existing breeder program, and to redirect it toward evaluation of alternative breeders, advanced converter reactors, and other fuel cycles, with emphasis on nonproliferation and safety concerns. He has also called for cancellation of construction of the Clinch River Breeder Reactor Demonstration Project and all component construction, licensing, and commercialization efforts.

To encourage other nations to pause in their development of plutonium-based technology, the United States should seek to restore confidence in its willingness and ability to supply enrichment services. The United States will reopen the order books for U.S. uranium enrichment services, and will expand its enrichment capacity by building an energy-efficient centrifuge plant. The President is also proposing legislation to guarantee the delivery of enrichment services to any country that shares U.S. nonproliferation objectives and accepts conditions consistent with those objectives.

To resolve uncertainties about the extent of domestic uranium resources, ERDA will reorient its National Uranium Resources Evaluation Program to improve uranium resources assessment. The program will also include an assessment of thorium resources.

The United States has the option of relying on light-water reactors to provide nuclear power to meet a share of its energy deficit. To enhance the safe use of light-water reactors:

> the Nuclear Regulatory Commission (NRC) has already increased the required number of guards at nuclear plants and the requirements for the training that guards receive;
>
> the President is requesting that the NRC expand its audit and inspection staff to increase the number of unannounced inspections and to assign one permanent Federal inspector to each nuclear power plant;
>
> the President is requesting that the Commission make mandatory the current voluntary reporting of minor mishaps and component failures at operating reactors;
>
> the President is requesting that the NRC develop firm siting criteria with clear guidelines to prevent siting of nuclear plants in densely populated locations, in valuable natural areas, or in potentially hazardous regions.

The President has directed that a study be made of the entire nuclear licensing process. He has proposed that reasonable and objective criteria be established for licensing and that plants which are based on a standard design not require extensive individual licensing.

To ensure that adequate waste storage facilities are available by 1985, ERDA's waste management program has been expanded to include development of techniques for long-term storage of spent fuel. Also, a task force will review ERDA's waste management program. Moreover, improved methods of storing spent fuel will enable most utilities at least to double their current storage capacity without constructing new facilities.

Hydroelectric Power

The Department of Defense (Corps of Engineers), together with other responsible agencies, will report on the potential for installation of additional hydroelectric generating capacity at existing dams throughout the country.

Nonconventional Resources

America's hope for long-term economic growth beyond the year 2000 rests in large measure on renewable and essentially inexhaustible sources of energy. The Federal Government should aggressively promote the development of technologies to use these resources.

Solar Energy

Solar hot water and space heating technology is now being used and is ready for widespread commercialization. To stimulate the development of a large solar market, a tax credit is proposed. The credit would start at 40 percent of the first $1,000 and 25 percent of the next $6,400 paid for qualifying solar equipment. The credit would decline in stages to 25 percent of the first $1,000 and 15 percent of the next $6,400. The credit would be supported by a joint Federal-State program of standards development, certification, training, information gathering, and public education. Solar equipment used by business and industry would be eligible for an additional 10 percent investment tax credit for energy conservation measures.

Geothermal Energy

Geothermal energy is a significant potential energy source. The tax deduction for intangible drilling costs now available for oil and gas drilling would be extended to geothermal drilling.

Research, Development and Demonstration

An effective Federal research, development and demonstration program is indispensable for the production of new energy sources. The Federal Government should support many research options in their early stages, but continue support into the later stages only for those that meet technical, economic, national security, health, safety, and environmental criteria. Research and development should be accompanied by preparation for commercialization so that successful projects can rapidly be put to practical use.

Additional research, development and demonstration initiatives are proposed, with emphasis on small, dispersed and environmentally sound energy systems.

An Office of Small-Scale Technologies would be established to fund small, innovative energy research and development projects. The office would enable individual inventors and small businesses to contribute to the national energy research and development effort.

Information

A three-part energy information program is proposed. A Petroleum Production and Reserve Information System would provide the Federal Government with detailed, audited data on petroleum reserve estimates and production levels. A Petroleum Company Financial Data System would require all large companies and a sample of small firms engaged in crude oil or natural gas production to submit detailed financial information to the Federal Government. Data required from integrated companies would permit evaluation of the performance of their various segments by providing vertical accountability. An Emergency Management Information System would provide the Federal and State governments with information needed to respond to energy emergencies.

Competition

Effective competition in the energy industries is a matter of vital concern. The Under Secretary for policy and evaluation in the proposed Department of Energy would be responsible for making certain that policies and programs of the Department promote competition. Although at this time it does not appear necessary to proceed with new legislation for either horizontal or vertical divestiture of the major oil companies, their performance will be monitored. The proposed information program would greatly assist that effort.

A present anomaly in the availability of the tax deduction for intangible drilling costs within the oil industry would be removed as part of the program for extending oil and natural gas price controls.

Emergency Assistance for Low-Income Persons

Existing emergency assistance programs are deficient in assisting low-income persons to meet sharp, temporary increases in energy costs due to shortages or severe winters. A redesigned program will be completed promptly and submitted to the Congress.

U.S. NATIONAL ENERGY POLICY: THE FEDERAL ROLE *

(By Frances A. Gulick [1])

INTRODUCTION

It has become customary to note the fact that there is no comprehensive, coordinated statement of U.S. energy policy and no comprehensive coordinated Federal energy program. More than sixty Federal agencies with multiple counterparts at regional, State and local levels wield a wide range of authorities under an even wider range of laws and regulations. Collectively, their operations make up the legal environment within which the Nation's total energy supplies are being produced and consumed, although their collective laws and regulations have not been formally codified in any statement of energy policy.

The lack of a comprehensive policy statement or a coordinated Federal program does not mean, however, that the United States has not had a Federal energy policy in the past. On the contrary, there was a national energy policy based on a broad consensus. It was fairly specific, fairly clear cut, and it operated over the past half century under widely accepted assumptions and under broad bipartisan Federal and State legislation, endorsement and support.

That policy has been to rely to the maximum degree on private enterprise to make the major investment, development, and pricing decisions affecting energy supply, to thus deliberately delegate to the private sector authority and responsibility for determining the evolving shape and direction and content of national energy policy as a whole.

TWO STATEMENTS OF U.S. ENERGY POLICY

One of the more articulate statements of this policy was presented by J. Cordell Moore, then Assistant Secretary of the U.S. Department of the Interior, to the Energy Committee of the Organization for Economic Cooperation and Development (OBCD) in January 1967:

> The very core of U.S. energy policy is that industry is responsible for production, distribution, marketing, and pricing, except in markets where fair prices cannot be guaranteed by competition, such as, for example, gas and electricity in interstate commerce. The Federal Government attempts to establish a climate favorable for the growth of the energy industries. It tries to stimulate initative, to help advance technology, and to encourage and maintain competition. It moni-

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*Appearing in Project Interdependence: U.S. and World Energy Outlook Through 1990, A Report prepared by the Congressional Research Service printed for the use of the Committees on Interstate and Foreign Commerce, U.S. House of Representatives, and Energy and Natural Resources, Commerce, Science and Transportation, U.S. Senate. November 1977. pp. 99–107.

[1] Francis A. Gulick is an analyst in Environmental Policy at the Congressional Research Service.

> tors the overall energy situation to be sure that the national security and the broad interests of the public are protected, it applies constraints to the operations of the private sector where the public interest so requires, and it makes liberal use of the instrument of persuasion at times to influence the course followed by the private sector. But the Federal Government does not control production, it does not direct the efforts of industry, and it does not involve itself in company affairs. Even in the regulatory field its posture is mainly reactive rather than positive. Information on costs, reserves, processes, and plans is generally closely guarded by the companies and they are not required to divulge it * * *. I stress our lack of authoritative knowledge concerning these matters because it is a basic part of our policy, and contrasts, I am sure, with the situation in nations in which the energy industries are nationalized.
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> * * * * * * *
>
> In stressing * * * the lack of direct U.S. Government control over many aspects of our energy situation, I am outlining the essence of American energy policy and strategy. We try to achieve our objectives in the energy field by stimulating initiative in the private sector rather than by directing it or doing the work ourselves. We limit regulatory measures to areas where our objecives cannot be achieved by competition. And we attempt to avoid protective and other measures that add to cost, seeking instead to solve long-range problems of security of supply, cost, and other objectives through technologic advance.[2]

This interpretation of the Federal energy role as subordinate to the decisions of the private sector was rearticulated in similar terms in the Report of the President to Congress on "The Organization of Federal Energy Functions," issued in January 1977 on the eve of the inauguration of a new Administration:

> While there has been a significant increase of Federal activity in and influence on the national energy system, the private sector continues to play the dominant role in the functioning of the complex series of economic activities which constitute the total national energy system. However, as in other sectors of the market, there are imperfections in the energy markets, both national and international; there are social costs related to the production, transportation, and use of various fuels that are not reflected in the market prices of those fuels; and there are national security interests to be safeguarded. Therefore, the Federal Government is required to carry out a significant number of functions and roles in concert with or in supplementation of the activities of private firms and consumers which participate in the energy system.
>
> Intensive R. & D. programs have been launched in pursuit of various national goals, such as the defense effort, space exploration, and overcoming disease. The goal of energy R. & D. and technology development is improved energy conservation and new and improved supply sources. Unlike the defense and space programs, however, the consumer of the energy technology produced by governmental assistance is the private sector. In short, the Federal energy R. & D. program is aimed at enhancing energy technology utilized by the private sector.
>
> The role of the Federal Government in energy RD&D is supplementary: to do what cannot be or is not being done by the private sector. Government can establish an appropriate policy climate for private sector action, share risks with the private sector, and conduct complementary RD&D programs. The assumption is that the private sector is prepared to take risks, has the inherent flexibility to act, controls the major share of new investment funds, and possesses the necessary managerial capabilities for carrying out most of the RD&D and virtually all of technology introduction. Generally, market forces will determine the economically optimum mix of alternative energy technologies. In some situations, the Government's regulatory role greatly affects the introduction of technologies. For example, changed Government price regulations on oil and gas could make conservation technologies and more expensive enhanced-recovery

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[2] "Part I: Observations on United States Energy Policy," a paper dated Nov. 1, 1966, prepared as background for the Confrontation on U.S. Energy Policy for the 11th session of the Energy Committee of the OECD in Paris, Jan. 26–27, 1967; and "Part II: Some Distinguishing Features of United States Energy Policy," his opening remarks at the session on Jan. 26, 1967. Texts reprinted in Senate Interior Committee Print, No. 93–43 (92–76), Energy Policy Papers, 1974, pp. 321–353.

techniques for oil and gas more attractive. Similarly, changing regulation or nuclear plants and other major installations, within acceptable safety standards, could speed construction and lower the cost of the technologies.[3]

BASIC ENERGY POLICY ASSUMPTIONS

Central among the basic assumptions on which this national energy policy has been based have been the following which relate to domestic energy supplies and to domestic energy prices and pricing policy:

There are and will be sufficient domestic energy supplies, available in acceptable quantity and form, to meet the country's present and foreseeable expanding economic needs.

These energy supplies can, and should, be made available at the lowest possible costs and prices, consistent with reliability of supply. Consumer choice among various kinds of fuels can be counted on to produce competition among supplies which in turn will provide incentive to keep energy prices low.

RELATIVE ROLE OF THE PRIVATE AND PUBLIC SECTOR

The relative roles of the private and public sector in framing and regulating resultant national energy policy flow from these two assumptions. Simply stated they are:

Private enterprise can, and should, be relied on to the maximum degree to explore, produce, distribute, market, and price an evolving blend of fuels.

Federal intervention in this process should, and can, be strictly limited to measures which would maintain a business and regulatory environment conducive to abundant and low cost energy and to provide a leading role in financing research in new energy technologies. It should be essentially residual, operating in the interest of and supporting the efforts of private enterprise.

It is certainly true that this limited Federal role has taken highly visible form. In addition to such readily identifiable functions as regulation of natural gas and utility rates, the Federal Government has pioneered in development of hydroelectric power and in development and demonstration of nuclear energy and in production of enriched uranium for nuclear fuel. Statistically, however, production in Federal facilities amounts to only a small fraction of total civilian electrical suppies, still less than 3 percent in 1976, mainly in the form of electric power from hydroelectric stations. TVA, the Corps of Engineers, and the Bureau of Reclamation produce and market power from both thermal and hydro sources. The Nuclear Regulatory Commission controls the imports and exports of uranium, thorium, and other fissionable materials. ERDA manufactures and markets enriched uranium and may have to provide long-term management for highly radioactive nuclear wastes. All of the electricity from nuclear power plants in the United States that are fueled with enriched uranium, therefore, depend on the Federal Government for this necessary fuel supply. As landlord, the Federal Government wields significant power, owning—and leasing to the private sector—about 34 percent of the total land area. The mineral rights to an even larger area, including the Outer Continental Shelf, are also under Federal control.

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[3] The Organization of Federal Energy Functions. Message from The President of the United States, transmitting his recommendations for the Reorganization of Federal Energy and Natural Resources Activities, pursuant to sec. 162(b) of the Energy Conservation and Production Act of 1976, Jan. 12, 1977. Issued as House Document No. 95–43, 95th Cong., 1st Sess., pp. 10, 33.

Nevertheless, as measured by both the proportion of energy produced and marketed and by the intent of the policy, the Federal role in and control over the development of energy policies and patterns of use has been deliberately subordinated to the concept of least feasible interference with market decision and maximum reliance on private initiative and enterprise.

Liberal tax incentives such as extensive depletion allowances for energy extraction and provisions allowing generous expensing of exploration costs had been regularly reenacted with only minor changes for nearly sixty years before the changes reflected in the Tax Reduction Act of 1975, Public Law 94–12, signed March 29, 1975.[4]

Similarly, Congresses of varying political persuasions have regularly reaffirmed support of the Interstate Compact to Conserve Oil and Gas,[5] an endorsement which since its first enactment in 1935 has served to reinforce the intent to rely on State laws promoting energy conservation and market stability by, among other measures, encouraging adjustment of supply to demand through prorating of production among the private producers of oil and natural gas.

An examination of energy related Federal laws and directives through 1973 confirms this relatively self-limiting Federal role in energy policy formulation.

A compilation of Federal laws relating to fuel and energy resources, prepared for the House Committee on Interior and Insular Affairs and issued in December 1972, reviewed and reprinted the energy-related sections of some 40 major laws, collating them by agency, and concluded:

> If nothing more, arranging these laws by administering agency serves to underscore both the large number of agencies and other offices having some responsibility in the energy field, and the lack of central control over energy policy.[6]

The result has been that, with very few exceptions the major substantive national energy policy decisions—decisions which are now the object of tumultuous congressional reconsideration—were deliberately made the responsibility of the private sector.

These critical responsibilities, accepted and energetically exercised by the private sector, shaped national patterns of energy production and use in such fundamental policy vectors as: The amount and direction of energy investment; the extent and location of exploration; the volume and rate of production; the direction and mode of distribution; the relative mix among various fuels; decisions on prices at wholesale and retail level; and the degree of national dependence on imported fuels.

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[4] In addition to a number of changes which reduce exemptions involving foreign income, this law repealed the 22 percent depletion allowance in its entirety for all major oil and natural gas producers, identified as those producing more than 2,000 barrels of oil per day, or 12 million cubic feet of natural gas per day postponing its abolition for independent companies who do not have retail outlets and produce less than these amounts, on a graduated schedule until 1984. The depletion allowance was continued for other extractive fuels.

[5] Most recently, in S.J. Res. 126, to extend the compact through Dec. 31, 1978, which passed the Senate M[illegible] 4, 1976. See "Interstate Oil Compact Extension," Hearing before the Senate Committee on Interior and Insular Affairs, 94th Cong., second sess., on S.J. Res. 126, Mar. 24, 1976, summarizes recent discussions on the role of pricing as a conservation tool, in the context of the original purposes of the compact set out in article II.

[6] U.S. House of Representatives, Committee on Insular Affairs, 92d Cong., 2d sess., "Compilation of Federal Laws Relating to Fuel and Energy Resources," Committee Print 92–7, 896 pp.

In sum, it has been U.S. policy to rely to the maximum degree on private enterprise in the competitive market system to shape and make the principal components of U.S. national energy policy.

It is in this context—an up-to-now deliberately self-limiting and residual Federal role—that U.S. national energy policy needs to be understood and is now being reassesed.

CHANGES IN THE BASIC ASSUMPTIONS

Foremost among the facts on which a major reassessment is now taking place is that the first two assumptions have greatly changed, so much so as to strip national energy policy of much of its underlying rationale.

1. Domestic supplies.—As this whole report makes abundantly clear, domestic energy supplies are no longer able to meet all of our burgeoning demands. By the end of 1976, the country was importing oil and refined oil products equal to one-fifth of total energy demand and equal to some 42 percent of total petroleum demand. In January 1977, imports soared to more than half of total petroleum demand; first quarter imports averaged 9 million b/d. Four-fifths of those imports came from OPEC lands. With the exception of DOD and other public sector procurement, virtually all petroleum imports are purchased and managed by the private sector. Production of domestic oil and natural gas has peaked, recoverable domestic reserves are dwindling and are likely to be exhausted around the end of the century. Meanwhile substantial safety, environmental and technical problems impede their rapid replacement by coal and nuclear energy.

2. Domestic prices.—Concurrently the domestic U.S. market has lost whatever independent influence it may once have had over energy price and pricing policy through competition among suppliers for a growing domestic market to keep energy prices low. The already quadrupled and still rising prices of imported crude, set now by OPEC producers, provide the main influence on not only the composite refiner acquisition costs of crude but also on other domestic energy supplies, now enhanced in value as demand for oil keeps oil prices high.

REASSESSMENT OF THE RELATIVE PRIVATE AND PUBLIC ROLES

These two changes stimulated Congress into a major reassessment of this long standing policy. A series of enactments during the 93d and 94th Congresses laid the base for a new codification of national policy on energy. (See below.) They served, if nothing else, to make Congress and the public in general far more conscious than before of how residual the Federal role in national energy policy has been.

A careful review of the substance of these recent laws confirms the fact that, while the reassessment process is well under way, the changes so far enacted represented only very limited modifications in the long standing major premises: the Federal role is still residual, the private role still dominant.

To cite just one key example, regulation of crude oil pricing: The initial price controls affecting crude oil were not directed specifically at oil alone but were part of a general wage and price management effort, dating from August 1971, to moderate inflationary pressures in the economy as a whole. By mid-1973, crude oil was the last commodity still remaining under price control and the OPEC embargo and quadrupling of oil prices interrupted a phase-out already underway.

The elaborate interim allocation/entitlement/two-tier price arrangements, authorized under and resulting from the Emergency Petroleum Allocation Act of 1973, were enacted as emergency and intentionally temporary measures to cope with a market now violently in flux.

The consensus reached in Public Law 94–163, signed December 22, 1975, and extended, as amended, by Public Law 93–385, signed August 14, 1976, as the Energy Policy and Conservation Act, established a policy, not of continued price control but of price decontrol, carefully monitored and moderated, permitting a rise over a little more than three years to a new world market rate. The graduated, instead of sharp, rise was intended to cushion the impact on an economy still coping with high levels of unemployment and inflation, but the purpose and end result was price decontrol.

NEW STATEMENT OF U.S. ENERGY POLICY

With the advent of the new Administration, a major and dramatic shift in basic U.S. energy policy has been proposed.

In a series of presidential addresses, documents and proposed legislation the Administration has laid out the outlines of a comprehensive energy plan intended to achieve a significant reduction of oil imports, by 1985, through a series of specific production, conservation and fuel switching goals.

There is very little within the detailed proposals or even the goals which can qualify as "new"—with the exception of two of the ten principles which are set forth to "provide a framework not only for present policies, but also for the development of future policies."

Eight of the ten principles represent general findings already embodied in legislation currently in force, calling for a U.S. energy policy which is healthy to the economy; protects the environment; emphasizes conservation; is secure, fair and energy efficient; is predictable; uses resources in plentiful supply and moderates the use of fuels which are scarce; and vigorously expands the use of nonconventional and renewable fuels.

Two of the principles, however, represent fundamental changes as compared with national energy policies and assumptions of the past—the assertion that (1) The Federal Government should take the leading role in dealing with the nation's energy policy comprehensively and that (2) energy prices should generally reflect the true replacement cost of energy. These are diametrically opposed to the national energy policies on which 50 years of energy and economic growth in the United States have been based.

The codification of earlier U.S. energy policy represented in the two previously quoted statements, by Interior Assistant Secretary Moore and by President Ford, is now directly challenged in the first principle of the Administration's proposed National Energy Plan:

> The energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively and by a public that understands its seriousness and is ready to make necessary sacrifices. The declining availability of oil and natural gas will affect virtually all energy prices

and consumption patterns in the United States, for the various energy supplies are all part of an integrated energy market. Therefore, in this democratic society, a solution can be found only in comprehensive Government policymaking informed by public comment and supported by public understanding and action.[7]

The second change which is at odds with past U.S. national energy policy premises—listed as the seventh principle—is that "energy prices should generally reflect the true replacement cost of energy."[8] Clearly this is very different from a policy premise that Federal policy should be to ensure that energy supplies should be made available at the lowest possible costs and prices, consistent with reliability of supply.

Under the Federal energy reorganization now underway, the Secretary of a new Department of Energy, consolidating a very wide range of energy policy and program authorities from half a dozen major energy agencies, will be the President's principal agent in attempting to wield this greatly expanded Federal policymaking responsibility and role.

Under regulatory powers conveyed by legislation enacted and still in force, the Federal Government is already authorized to:

Set prices for old and new oil, for old and new interstate natural gas; and for uranium enriched materials.

Set production goals for fuels on public land.

Determine, under relatively general guidelines, which fuels could be burned in which boilers.

Allocate coal.

Under emergency presidential powers, allocate oil, oil products and natural gas.

Negotiate the price for up to one billion barrels of oil for strategic stockpile storage.

Determine the quantity of gasoline which can be produced in domestic refineries.

Set standards for a wide range of industrial and consumer products, auto fuel efficiencies and thermal building requirements.

Control the exports of coal, oil, uranium, nuclear plants and equipment, and electricity.

Accelerate or slow down the rate at which additional nuclear electric power generating capacity will be authorized.

Create new energy supply industries through a combination of economic incentives, pricing powers, contracting authority and technological capabilities.

In the context of the new consolidation of energy agencies and the proposed new philosophy of a primary Federal policymaking role, these powers are formidable. Collectively they represent Federal authorities exercised in the past only in times of war, national disaster and emergency—if not "the moral equivalent of war", the peacetime regulatory equivalent of wartime powers.

CONCLUSION

Whether the President or a Secretary of Energy could actually successfully carry out such powers in the absence of war or similar national emergency is still questionable, particularly if the programs and policies to be enforced turn out to run counter to the de facto national energy goals represented by private sector desires and intent.

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[7] Executive Office of the President, Office of Energy Policy and Planning. The National Energy Plan, Washington, Apr. 29, 1977, 103 pp. Citation is on p. 26.

[8] Ibid. pp. 29–30.

Congress has not completed its own reassessment of national energy policy and it is by no means certain that it is prepared to endorse all of the proposed changes in the Federal energy policymaking role.

Meanwhile the major decisions in all the important energy policy vectors which make up national energy policy continue to be made, as they have in the past, by private sector investment plans and choice and will.

ENERGY PICTURE AT A GLANCE

Programs and authorities included in legislation already enacted

Strategic reserves.—Authorization to create a system of national strategic petroleum reserves of up to 1 billion barrels, and development and civilian use of naval petroleum reserves.

Emergency authority.—A wide range of standby energy emergency legislation, including continuing authority for allocation of scarce materials and petroleum, as well as end-use rationing of gasoline.

Energy pricing.—Permits carefully monitored and moderated increases in domestic crude oil prices to world price levels over a period of 39 months under new procedures ensuring close Congressional management, oversight and control. Stripper-well production is exempt from the price ceilings, effective September 1, 1976. Proposals for utility rate reform are to be prepared by FEA.

Conversion from oil and gas to coal.—Extended authority for the FEA Administrator to force industrial conversion from oil and natural gas to coal.

Energy conservation.—A $2 billion loan guarantee program to encourage industry and business to practice energy conservation; a $200 million grant program for a three-year weatherization assistance program administered by FEA; $82.5 million for a weatherization program administered by Community Services Administration; a two-year, $200 million loan-grant demonstration program to finance conservation and renewable resources in existing homes; $150 million to aid States in developing conservation plans; mandatory building standards are to be drawn up; mandatory labeling for energy-using appliances; additional funding to promote mass transportation, recycling and resource recovery: and mandatory fuel economy standards for passenger automobiles.

Energy, research, development, and demonstration.—Increased funding for solar and other renewable fuels, continued work on nuclear power research, and a quite substantial research and development program to promote the commercialization of electric vehicles.

Approved by the House of Representatives and by the Senate Finance Committee during the 94th Congress

Conservation tax and investment credits.—For homeowners and businesses who install new or improved insulation, better heating systems, solar and geothermal energy equipment, heat pumps and wind-related energy equipment.

Production investment credits.—Additional credits were provided to encourage investment in waste conversion equipment, organic fuel conversion, railroad equipment, deep mining coal equipment, coal liquefaction and gasification technology.

Thoroughly debated but still controversial

"Gas guzzler" taxes.

Natural gas deregulation.

Standby gasoline tax.

Tax on the business use of oil and natural gas.

Crude oil equalization tax (debated as a windfall profits/plowback investment tax).

New Proposals

The proposed utility program requiring all utilities to offer energy conservation installation and financing services.

Rebates of "gas guzzler" and gasoline taxes.

AN ECONOMIC APPRAISAL OF PRESIDENT CARTER'S ENERGY PROGRAM

(By Walter J. Mead)*

For the last 5 years there has been a uniform cry from concerned businessmen, environmentalists, oil people, and political figures calling for a "comprehensive national energy policy." National energy policy to date has consisted of a conflicting set of expedient measures, with domestic tax policies having the effect of subsidizing the flow of capital into petroleum production, while at the same time price controls have reduced profitability and tended to cancel out the first set of policies. Another tax policy has encouraged foreign oil production while import quotas prevented this subsidized production from entering the U.S. market. In the early 1970's the federal government forced public utilities to abandon coal-fired generators in favor of oil and gas turbines. Five years later the same government was mandating the opposite shift, at enormous social cost.

While a "comprehensive national energy policy" was obviously needed, very few people bothered to spell out in detail what set of policies they considered to be beneficial. Professional economists who specialize in energy research, as well as some spokesmen with a business orientation, had in mind policies which relied on the market forces of supply, demand, and price to allocate scarce energy resources among competing uses. But to political Washington, the cry for a national energy policy is interpreted as a demand for more government decision-making and less reliance on the market. Those who called for a "comprehensive national energy policy" and meant by it greater reliance on market forces must have been shocked when they read principle number one in the President's energy message. This first principle stated that "we can have an effective and comprehensive energy policy only if the Federal Government takes responsibility for it . . ." (*1*, p. 1). The essence of the President's energy message implements this first principle. Price controls for both oil and gas are not only extended to cover previously exempt areas, such as intrastate gas, but are also offered as permanent institutions (*2*, *3*).

Professional economists who have specialized in energy economics almost to a man have argued for greater reliance on market forces and less government interference in energy problems. Their strong preference for market solutions is not because they are philosophical conservatives. Rather they are acutely aware of the poor record of government interference in the energy market. That record is one of massive and repeated resource misallocation. Adelman wrote about "this whole system of organized waste" (*4*), while Erickson and Spann described the energy crisis as a "policy induced" (*5*) crisis.

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A HALF-CENTURY OF FEDERAL ENERGY POLICY IN REVIEW

The record of government intervention on behalf of various interest groups in the energy industry is well known to economists specializing in this area. The past is prologue. Congress, in legislating energy policy, must become aware of its own record. Let us briefly review the record of major federal government energy policy intervention.

(1) The percentage depletion allowance tax provision affecting oil, gas, and other minerals was introduced more than a half-century ago. One major effect was to increase the flow of capital into oil and gas exploration and production. This in turn increased the supply of petroleum from domestic sources and caused petroleum product prices to be lower than they would have been in the absence of this tax subsidy. This historically low price policy for energy led to both big cars and other evidence of wasteful consumption, and to premature depletion of the nation's resources. It contributed to the energy crisis of the 1970's.

(2) Tax provisions allowing the expensing of intangible drilling costs for productive wells contributed further to excessive capital flows into oil and gas exploration. The results were the same as those indicated in point 1 above.

(3) A third tax item, the foreign tax credit, stimulated a flow of U.S. capital into foreign petroleum exploration and therefore rapid production, artificially low prices, and more rapid resource depletion throughout the world. It also led international oil companies to enter other lines of business chartered in low-income-tax countries as a means of using excess foreign tax credits.

(4) During the 1930's, in the name of "conservation," the groundwork was laid for production controls ultimately taking the form of market demand prorationing. This is a monopolistic device enforced by government on behalf of the oil industry and was designed to reduce domestic production in order to cause oil prices to rise above competitive levels. This policy therefore tended to cancel out some of the supply effects of the tax subsidies identified in points 1 and 2 above. Market demand prorationing was authorized by two laws passed by Congress, laws authorizing the Interstate Oil Compact and the "Connally Hot Oil Act" which provided the enforcement mechanism (*6*).

(5) As another monopolistic device, in 1959 the Eisenhower Administration introduced mandatory oil import quotas having the effect of restricting petroleum supplies from abroad and thereby depleting domestic resources at a faster rate. Quotas were introduced at the insistence of independent crude oil producers, joined by coal producers, and over the opposition of the major international oil companies (*7*). Import quotas caused domestic crude oil prices to be about $1.25 per barrel above the imported crude price until about 1971. The private interest need for import quotas followed from the efforts under market demand prorationing to maintain artificially high oil prices in the United States. Market demand prorationing restrictions on domestic supply designed to increase prices could not work for long without parallel restrictions on imports. At the same time, import restrictions prevented the free flow of imported oil subsidized by the foreign tax credit listed in point 3 above. This subsidized oil therefore flowed to Western Europe and elsewhere, benefiting either

foreign consumers in the form of lower prices or foreign governments in the form of higher excise tax receipts at the expense of American taxpayers and consumers.

(6) Natural gas price controls originated in a 1938 act of Congress. A Supreme Court decision in 1954 stated that Congress intended price controls to cover the wellhead price of natural gas flowing in interstate commerce. This action, as administered by the Federal Power Commission, continued the historically low price policy for energy. Prices were set below market clearing levels leading both to wasteful consumption and to the severe shortages in early 1977.

(7) Price controls over crude oil and products were instituted in 1971 by the Nixon Administration. To the extent that oil prices are set below market clearing levels, product shortages have resulted. But there is an open-ended oil supply. Declining domestic production from a peak of 10 million barrels per day in 1970, down to about 8 million barrels per day currently, paired with increased consumption, is leading to vast increases in imports and consequent dependence and balance of payments problems.

(8) With the introduction of multiple-tier pricing as part of price controls, a mechanism must be established to decide who is to be favored with low-priced crude and who must buy the high-priced imports. This led to an allocation program requiring that some firms sell crude and products to others. This is an income redistribution system that also distorts an efficient flow of resources.

(9) In addition, the price control system led to politically perceived "inequities" between different refiners and between different parts of the country. Therefore, another offsetting income redistribution system was established called "entitlements" requiring that money in large amounts (about $1 million per year) be passed from one group of refineries to another. Even the President's document admits that the entitlements program is "an administrative nightmare" (*8*, p. 49).

(10) Early in the present century a system of four naval petroleum reserves was established. The largest known reserve is Elk Hills in California. During the Arab oil embargo, Congress debated, but was unable to authorize, a single barrel of oil production from Elk Hills to alleviate the harsh economic effects of that embargo. Now that there is an apparent glut of oil developing on the West Coast with the introduction of North Slope crude into this market, Congress has legislated production scheduled to expand to 350,000 barrels per day, thereby contributing to the West Coast oil glut.

(11) In the 1920's Congress passed the Jones Act requiring that all marine shipments between two U.S. ports be on tankers (i) built in the United States, (ii) owned by American companies, and (iii) manned by American crews. This act has created a domestic monopoly position for each of the three interest groups covered. It now requires that consumers bear the added cost of Jones Act shipping for Alaskan crude oil. The 94th Congress passed the tanker bill that would extend Jones Act conditions to 30 percent of the oil imported into the United States from abroad. This was done at a time when surplus tankers were tied up all over the world. Compliance with the tanker bill would have required massive tanker construction in the United States, there-

by contributing to the tanker surplus. It would also have imposed a burden on American consumers estimated at about $2 billion per year. But for a presidential veto, the tanker bill would be the law of the land.

Perhaps the foregoing 11 items are sufficient to illustrate why energy economists have not been enthusiastic about additional governmental intervention in the energy market. This record does not lead one to be confident that the public interest will be served by additional government intervention. This record should surprise no one. Congress and the Administration must respond to dominant organized pressures. The President's first principle, suggesting that an effective and comprehensive energy policy requires that the government take responsibility for it, implies that government intervention in the future will wisely serve the general welfare, in contrast to the historical record.

SOME COMMENDABLE FEATURES IN THE PRESIDENT'S ENERGY PROGRAM

The President's energy message contains several admirable statements and recommendations, from an economic efficiency point of view.

(1) Allocation efficiency will be improved by the President's proposal to let the price paid by users of crude oil rise to the world price. However, this is only half of the market solution, which would allow both the demand price and the supply price to be set by the market rather than by the government.

(2) A presidential directive requiring federal agencies to purchase cars that exceed the average fuel economy by 2 percent in 1978 and 4 percent in 1980 appears to be commendable, as an economy measure.

(3) Some of the reforms of public utility rate regulation will lead to greater economic efficiency in that regulated industry. First, peak-load pricing is long overdue. If implemented, it should shift power usage from normal peak-load periods and thereby reduce the need for new construction. Second, the President's proposal to phase out promotional rates and declining rates that are not justified by declining costs will contribute to greater efficiency. Third, the President's proposed prohibitions on master metering for electricity structures will lead renters to economize on power usage. The present system of master meters in such structures leads renters to treat electric power as a free good and hence to use it excessively.

(4) The President notes that oil and gas are now priced "below their marginal replacement cost and, as a result, the nation uses them wastefully with little regard to their true value." This is a true statement and one might take encouragement from the fact that it is enunciated by the President. However, in the next paragraph of his message he states that "the residential sector is sheltered as the plan would keep natural gas prices to residential users down and provide tax rebates for home oil use" (*1*, p. 15). It is clear that his policy recommendations perpetuate the very problem that he has so well identified.

(5) The President's proposal seeking legislation to limit production from the Elk Hills Naval Petroleum Reserve to a ready-reserve level until the West-to-East transportation systems for moving Alas-

kan oil surplus are in place, and until California refiners have completed a major refinery retrofit program to enable more Alaskan oil to be used in California, is commendable. The proposal could be improved by eliminating its temporary character and placing the Elk Hills Reserve in a permanent, fully developed standby reserve position.

(6) The exemption of shale oil from the President's proposed price control system will enable oil production from our vast shale oil reserves to proceed whenever cost and market conditions justify such production.

(7) The President's proposal to expand the strategic petroleum reserve to the point where the nation could withstand a 10-month supply interruption appears to to be desirable. With this reserve the nation could accept a relatively high level of imports from the Middle East. While this policy will involve balance of payments probems, it is at least consistent with the fact of life that the large remaining known reserves of crude oil are in the Middle East and not in the United States. It enables us, with reduced risk, to delay developing major supplies of very high cost energy sources as alternatives to imported crude oil.

(8) After observing that the present gasoline price control system is inoperative (prices are determined by competitive conditions), the President wisely recommends gasoline price decontrol.

SOME QUESTIONABLE POLICY PROPOSALS

In addition to the recommendations noted above, which appear to offer greater resource allocation efficiency, there are other recommendations that might possibly be worthwhile on efficiency grounds. The plan calls for a large number of programs that all suffer from a common fault—they are not supported by evidence showing that their social benefits exceed their social costs. These programs include the following:

(1) New cash subsidies for individuals, home owners, schools, and hospitals to finance weatherization and the installation of miscellaneous "approved conservation measures."

(2) New tax subsidies to business to encourage installation of "qualifying solar equipment," "approved conservation measures," and "cogeneration equipment."

(3) Federal investments in van pooling (6000 vans to be purchased) for use by federal employees in commuting to and from their jobs. The fact that large-scale unsubsidized van-pooling arrangements have not been successful leads to the suspicion that the self-supporting feature of this proposal will not materialize.

(4) In the event that voluntary programs fail to achieve prescribed results, then mandatory measures are proposed relative to weatherization, efficiency standards in new buildings, and home appliance efficiency standards.

The economic problem in all these proposals is that subsidies and governmental force will likely cause scarce resources to be allocated to uses that have a low or negative rate of return to society, unless net external benefits are present. External benefits accrue to society at large, rather than to the individual or business decision-maker. There is no showing of net external benefits in the President's analysis. Where either subsidies or force lead to resource misallocation, the standard of living of the poeple will be unnecessarily low. Before Congress enacts any of these measures, it should require evidence that the discounted present value of the benefits exceed the costs.

One of the above measures may be used to illustrate the problem. As a force measure, Congress is considering legislation that would prohibit the sale or refinancing of any home not meeting prescribed federal insulation standards. A decision to insulate a home should be based on the present costs of insulation and the flow of future savings. If costs exceed benefits, such investments should not be made. An exception occurs if there are net external benefits. None are obviously present. If this calculation is distorted by artificially low prices for gas or other energy input, then the obvious correction should be to eliminate the source of the distortion—the current price control system. The President's program perpetuates this problem by extending gas price controls and making both gas and oil price controls permanent.

Costs and benefits will differ widely by geographical area, age of the house, difficulty of retrofitting, temperature preferences of individuals, and the like. In the absence of net external benefits, home insulation decisions should be made by home owners, not by a distant Congress.

SOME OF THE PRESIDENT'S PROPOSALS ARE COUNTERPRODUCTIVE

The President proposes two extensions of existing tax subsidies.

(1) According to the President's plan, some independent oil and gas producers have been deprived of a portion of the tax reduction enacted in 1976 for the expensing of intangible drilling costs. As a solution to this problem, he proposes that the intangible drilling cost expenditure provision be liberalized. However, further liberalization of tax subsidies will make oil production more profitable after taxes. This is in conflict with the President's own price control measures, which are designed to restrain profitability. Further, a tax subsidy, unsupported by evidence of net external benefits, leads to overinvestment in the subsidized industry and to resource misallocation. Instead of further liberalization, Congress should consider eliminating existing legislation which permits expensing of intangible drilling costs for productive wells and requiring instead capitalization of such expenditures. This provision, of course, should be applicable to all oil and gas producers equally. In a similar vein, complete elimination of percentage depletion allowance for all mineral production, regardless of firm size, should be considered by Congress.

(2) In addition, the President proposes that expensing of intangible drilling costs as a tax stimulant be made available to geothermal energy production. The reasoning above applies here also. Further, a tax subsidy for geothermal energy places alternative energy sources including, for example, solar, wind, and fuel from waste at a relative disadvantage. Instead of extending tax subsidies to additional energy sources, a preferable policy would be to eliminate such non-neutral tax provisions from all present applications.

Strong endorsement is given by the President to the amendments to the Outer Continental Shelf Lands Act now being considered by Congress. Currently available economic research shows that the competitive bonus bidding system now in effect has produced more than fair market value to the government and has introduced a low level of inefficiency into the production process. In recent testimony before the House of Representatives, evidence was presented indicating that the proposed amendments to alter the bidding process would be counterproductive in that they would cause valuable petroleum resources to be left in the ground and the public would receive lower payments from lessees. This lengthy evidence is available (*9*).

The quality of the economic analysis supporting the President's program appears to be poor. First, the analysis argues that "Without constraints, U.S. oil demand probably would grow at the postwar rate of 4 percent per year, and reach 25 million barrels per day by 1985" (*8*, p. 11). This projection appears to assume that the demand for oil has a long-run elasticity of zero, a highly unlikely condition. Price appears to have been ignored in the analysis. In the absence of intervention, the price of crude oil would be about $14 per barrel, currently, compared to about $3 per barrel when the postwar consumption growth rate used in the above quotation was being established. At higher prices prevailing under uncontrolled conditions, people will economize (conserve), and consumption growth rates will be reduced.

Second, the analysis sets out to reduce "energy consumption." This is a myopic view of economic problems. Conservation, as an economic problem, requires that *all resources* be conserved, not just energy. Policies that use tax incentives and the allocation power of government to mandate reduced energy consumption lead, through resource substitution, to higher consumption of other resources (copper, insulation, steel, and the like) as if they had no value. Such policies are counterproductive with respect to resource conservation. This "energy myopia" is an unfortunate and serious economic flaw in the energy plan.

PRICE CONTROLS CREATE SHORTAGES

The most important issue in the President's energy plan is price policy. Two major alternative policies are available. First, the price system can be allowed to allocate scarce energy resources among competing uses with government interference limited to correcting for significant externalities. This would also constitute a "comprehensive national energy policy." Second, price controls can be retained with the government making the important economic decisions about energy prices and about who is to be favored with artificially low-priced energy. The President clearly chooses the second alternative. "The President is committed to the retention of domestic oil price controls for the foreseeable future . . ." (*1*, p. 15). For natural gas, the President proposes that price controls be extended to include intrastate natural gas as well as synthetic natural gas.

The nation has had a long history of periodic experience with price controls. In the case of natural gas, the Federal Power Commission has controlled wellhead prices of interstate gas since 1954. These controls have created massive shortages. As a result, consumers of natural gas who have gas hookups are able to buy gas at low prices and use all they desire while others cannot buy gas at any price. This growing shortage became acute early in 1977. Further, one can accurately forecast that, if controls are continued, the shortage will increase in severity.

After noting, first, the inconsistency in the present system which permits gas transported in intrastate commerce to be free of federal price controls while the wellhead price of gas flowing in interstate commerce is subject to control by the Federal Power Commission (8, p. ixx), and second, that, under FPC control, natural gas "is now the Nation's most underpriced and oversold fuel" (*1*, p. 16), one would expect that the President would call for decontrol of new natural gas supplies. Instead, he recommends the opposite, that wellhead price control be extended to include intrastate gas. This policy is recommended as "an important first step toward deregulation" (*1*, p. 16). He proposes that all new gas be subject to a price limitation based on a Btu (British thermal unit) equivalency which is estimated to be $1.75 per MCF (thousand cubic feet) at the beginning of 1978. However, even at 1 June 1977 prices, a Btu equivalency would require a natural gas price of about $2.35 per MCF on the basis of import prices for crude oil, and $3.15 on the basis of heating oil prices. Therefore, even ignoring any cleanliness or convenience premium that the market would automatically accord to gas, natural gas would continue to be "the Nation's most underpriced fuel."

In addition to expanding the regulatory burden to include intrastate gas, the President proposes a complex and expensive six-tier system of controls with price distinctions based on (i) new gas, (ii) old interstate gas subject to existing contracts, (iii) old interstate gas made available at the expiration of existing interstate controls, (iv) the same class of gas formerly sold in intrastate commerce, (v) "specific categories of high cost gas," (vi) synthetic natural gas.

The foregoing are producer prices. As soon as the government intervenes to set prices below market clearing levels, then a nonprice rationing system becomes a necessity. All consumers will want to receive gas at the lowest tier price. The government must then decide which users are to be the favored buyers. This adds to the expense of administration and results in a political rather than an economic allocation of resources.

Further, the President proposes an incredibly complex and confusing system of user taxes. First, industrial users (except fertilizer manufacturers and "certain agricultural users") would be subject to a 30¢ per MCF tax in 1979, increasing to an "average tax" of $1.10 per MCF. Second, the tax liabilities of fertilizer manufacturers and "certain agricultural users" are unspecified. Third, utility users of natural gas would pay a tax beginning in 1983 sufficient to raise their cost of gas to 50¢ per MCF below the Btu equivalent price of distillate, increasing by 1988 so that their cost of gas would equal the cost of distillate. Since gas has the advantages of cleanliness and capital cost saving, it would remain a bargain for all three users listed above. In the long run, these taxes would be paid by consumers. Fourth, no tax is specified for residential customers for whom prices are to be kept low. A rationing system would be established requiring that the more expensive gas be allocated to industrial users, not to residential and commercial users. By keeping gas prices low for consumers, normal incentives leading toward home insulation and toward solar heat application are reduced.

The economic problems of this price and tax control system for gas are legion and observable from past experiences. A large bureaucratic burden would be required to administer the system. This must be paid out of lower living standards. Appeals must be heard from user interest groups who want to obtain low-priced gas and from producers who want to qualify for higher selling prices. Wasteful consumption of a valuable non-renewable resource will continue because prices for all users are held below market clearing levels. Scarce gas resources are forced into less efficient uses, thereby retarding normal improvements in living standards.

A simple alternative involving insignficant administrative and resource misallocation cost is available—let the market allocate this scarce resource by (i) not extending control to intrastate gas, (ii) immediately decontrolling all newly discovered interstate gas, and (iii) phasing out over a period of not more than 5 years all controls on the price of existing interstate production. This also is a national energy policy.

The President appears to be proposing four tiers of oil price controls. First, the present price of $5.25 per barrel for "old oil" is to be continued. Second, it is proposed that the present fixed price of $11.28 per barrel be continued. This price category has included what has been called "new oil." The designation now proposed by the President is "previously discovered oil."

Third, another price category to be called "newly discovered oil" is to be given a fixed "current world price." All three tiers are subject to general inflationary price increases. Newly discovered oil is defined as oil from a well drilled more than 2.5 miles (1 mile=1.6 kilometers) from an existing onshore well as of 20 April 1977, or more than 1000 feet (1 foot=0.3 m) deeper than any well within any 2.5-mile radius. New oil offshore will be limited to oil from lands leased after 20 April 1977. This artificial distinction will guarantee that all new wells will be drilled at least 2.51 miles from an existing well. It is a wasteful and counterproductive rule.

As a fourth tier, incremental tertiary (not including secondary) recovery and stripper oil production is to be free of controls. This provision, viewed alone, is welcome. However, as part of a four-tier producer pricing system, it is difficult and expensive to administer. Further, producers have learned from repeated past experience that rules can be changed by the government after investments have been made. There is a credibility problem.

The four tiers of price controls described above are producer prices. Market prices are to be allowed to rise to world oil prices, and the difference between the producer and market price is to be collected by the government in a four-tier taxation system.

THE PRICE CONTROL DILEMMA

The dilemma in which government finds itself arises out of the fact of a fourfold increase in the price of crude oil beginning about 1973. This fact has led to two governmental "hang-ups." One is based on "windfall profits," the other, on the impact on the poor.

For all remaining oil reserves existing at the time of this price increase, substantial inventory profits would occur as a result of the large increase in crude oil prices. These profits would be shared by private and government landowners (not oil companies) in the form of royalty payments, and lessees consisting of about 10,000 crude oil producers. The term given to this class of inventory profit is "windfall profit." It refers to an unexpected gain in value. It is more of a derogatory term than a precise economic concept. The concept is of questionable public policy usefulness for the following reasons:

(1) For all oil discovered on leases purchased after about 1974 when prices reached their present level (adjusted for inflation), the term windfall gain would not be appropriate if applied to producing oil companies. It would apply to the royalty interest, but in most cases this will be federal or state governments.

(2) Apart from the politics involved in the windfall gain terminology, it is not clear from the point of view provided by economic analysis that there are windfall gains even for reserves existing prior to 1973. Oil is a nonrenewable resource. It is possible that owners of oil reserves have long been expecting price increases. During the 1950's and 1960's any expected price increases failed to materialize. From 1950, when crude oil prices averaged about $3.07 per barrel, to 1977 when prices of imported crude amounted to about $14, the real price of crude oil (adjusted by the wholesale price index) increased at a compounded annual rate of 3.29 percent. This corresponds closely with the average real rate of return on capital over many years of U.S. history. It is possible that, in 1950, owners of oil resource did in fact expect this kind of gain. The problem is, the gain failed to appear from 1950 through 1970, then in 1973 it came suddenly.

(3) If the government is to use the windfall gain concept as an excuse for price controls then why single out crude oil prices when some other prices have also increased sharply? Spot prices of coal and of Douglas fir timber, for example, have both increased fourfold since 1967. Similarly, spot uranium prices (yellow cake) have increased in about the same proportion.

(4) How long are prices to be controlled in the name of historical windfall gains? The longer that prices are controlled, the greater are the distortions and the greater the accumulated cost of administration, both for the government and for complying industry. In the case of natural resources that have reached points in their production life cycle where the cheap sources have all been produced and only high cost sources remain, the price behavior to be expected is that of rising prices. This, in fact, is the way a price system automatically plans the allocation of increasingly scarce resources. Higher prices are needed to lead people to conserve and to search out substitutes. The longer that price controls are retained, the further from reality they become and the harder it is to dispense with them.

The second hang-up concerns the impact on the poor as a result of a sharp increase in the cost of crude oil and consequent product price increases. In order to avoid an adverse impact on the poor, government policy has sought to suppress price increases by using crude oil and natural gas price controls. This is an income redistribution policy. But it also distorts the flow of resources in the economy.

The income redistribution effect is haphazard. For example, poor people who do not have a natural gas hookup do not benefit by artificially low prices of natural gas, but owners of large houses with winter gas heat and summer gas air conditioning, plus swimming pools heated by gas, benefit immensely. The lesson to be learned from this experience is simple—do not adopt policies which have major resource misallocation effects in order to accomplish an income redistribution objective. Rather, if additional financial aid to the poor is desired by the nation, adopt policies that directly and efficiently (not haphazardly) serve that objective.

If the government finds it impossible politically to adjust to the new realities of crude oil prices, then the burden which we all will pay is continued price controls. The consequences of continued price controls for the nation as a whole are the following:

(1) As price controls have been administered to date, they have created shortages, particularly acute in the case of natural gas.

(2) The incentive to supply oil and natural gas from domestic sources is reduced. In the case of oil price controls, there is an open-ended supply in the form of imports. This leads to artificially high levels of imports and consequent balance of payments problems.

(3) Price controls involve administration costs in the form of allocations, entitlements, price policing, auditing, and the like. These administrative costs are not limited to government administration but include compliance costs imposed on industry. Whether the administrative costs of control are paid by government and thus taxpayers, or by industry, the social cost is the same. Valuable and productive people are diverted from alternative uses in order to administer and comply with the regulations. For the 1977 fiscal year, the Federal Energy Administration (FEA) alone employed 3478 people. The FEA budget, excluding costs for the strategic petroleum reserves, amounted to $158 million or $45,000 per employee. Rough calculations of the cost borne by the oil industry for compliance with FEA regulations indicate an annual charge of about $500 million. This, together with the FEA administrative cost, imposes a total social cost on the nation of approximately $650 million per year. It must be emphasized that this cost is both a private and a social cost, and it is only a small part of the government energy control cost. The resources involved have alternative uses. Talented and well-educated people are diverted from more productive uses of their time.

(4) When social costs are increased as a result of a control system without corresponding social benefits, economic growth and advances in living standards will be retarded. Resources that are devoted to a control system cannot be simultaneously used to produce other goods and services. One cannot argue that the talented human resources employed by the control system would draw from a pool of unemployed. For example, the system would employ a multitude of lawyers and economists. But there is no significant unemployment in either professional group. The present declining 6.9 percent unemployment rate consists primarily of unskilled labor.

The energy message asserts a contrary result claiming that the program would increase the GNP (gross national product) by 0.7 percent in 1978 and stimulate about 100,000 jobs by 1985 (*1*, p. 3). Given the mandated and tax-stimulated reallocation of capital away from uses to which such scarce resources would flow in response to normal market incentives, these favorable results are most unlikely. A recent analysis by Chase Econometrics, an economic forecasting organization, indicates GNP and employment consequences that are more realistic and in accord with economic theory. The Chase analysis concluded that "The overall effect of the energy program for the period 1978–1981 will be to reduce real GNP growth by 0.2 percent per year [and] raise the unemployment rate by an additional 0.1 percent per year . . ." (*3*, p. 2).

What are the offsetting benefits for this annual cost? Appraisals of the social benefits of FEA have indicated negative results. A recent study by the Rand Corporation concluded that "controls have not reduced the prices of refined products" (*10*). Instead, "refiners of controlled oil receive a profit transfer from the producer of the oil, but those profits are retained by the refiner" (*10*). Another study by Mancke concluded that "current energy policies have failed to alleviate any of our four energy problems. . . . In fact, they have actually worsened each of these problems" (*11*). Most recently, the President's Task Force on FEA regulations thoroughly reviewed the record and concluded that "FEA regulations as they now exist confer few, if any, benefits on the public. . . . In return for this lack of benefits and sense of false security, the American businessman, the taxpayer, and the petroleum consumer must incur higher costs than might otherwise be the case. Indeed, continuation of the present regulatory mechanism will result in long-run inefficiencies for the American economy" (*12*).

The system of price controls has distorted crude oil prices at the expense of producers and to the benefit of refiners. It has also shifted wealth between sections of the country, principally benefitting the New England area at the expense of other regions. If there are any positive contributions resulting from the system, they do not appear to be in the area of resource allocation but rather are in the area of income redistribution. Any such income redistribution benefits are highly dubious. Instead of extending price controls to cover additional energy sectors as proposed by the President, and instead of making price controls a permanent institution in this country as recommended by the President, Congress should move to phase out price controls.

CONCLUSIONS

(1) The universal cry for a comprehensive national energy policy is a cry of frustrated desperation reflecting a history of inconsistent, conflicting, and counterproductive energy policies.

(2) The federal government has interpreted this cry as a public demand for more federal intervention in the energy market.

(3) An examination of the energy policy record leads to the conclusion that past policy has not served the general welfare. Instead, government has responded, as one should expect, to dominant organized pressures from the oil industry, the coal industry, labor unions, environmental groups, special consumer interests, and the like.

(4) There is no evidence to suggest that government behavior in the future will differ from the past. Political incentives are unchanged.

(5) The comprehensive national energy policy that most professional economists specializing in the energy area appear to favor is one which limits government intervention in resource allocation to correcting for clearly demonstrated significant externalities. Otherwise, the market, not government, should be allowed to allocate scarce resources among competing ends.

SUMMARY

An analysis of 11 major federal energy policies of the last half-century indicated a record of conflicting and counterproductive government policies. These policies contributed heavily to the energy crisis. The essence of the President's energy plan is more government interference and less reliance on the price system. Crude oil price controls are to become permanent, and natural gas price controls are to be extended. This requires that government decide who gets the low-priced energy, who pays high prices, and who increasingly goes without. Government energy policies have historically reflected dominant organized pressures.

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ENERGY: THE UNITED STATES HAS A NATIONAL POLICY, AND IT'S WORKING

(By Art Pine)*

In the international hand-wringing over America's still-heavy energy consumption, the United States frequently is portrayed as an uncaring wastrel. Citing the massive foreign trade deficit, critics bemoan the failure to pass an energy bill as evidence that the U.S. doesn't have—or want—an energy policy. If only there were some legislation, they say, it would show signs of real commitment.

The myth began with Jimmy Carter, who campaigned in 1976 on the charge that the U.S. was the only major industrial nation that didn't have an energy policy. It wasn't really so then, but Americans accepted the notion almost without question. Now the battle cry has spread to Europe as well. Financial experts are blaming the lack of an energy policy for the decline of the dollar.

The fact is, however, that despite the absence of any grandiose formal energy program, the United States does have a national energy policy—and the evidence is it's working on a fairly significant scale. The changes began after the Arab oil embargo in the autumn of 1973. And they've been intensifying steadily ever since.

Without any major energy law to require it, Americans already are well on the way toward accomplishing some of the major goals of the Carter energy proposal—from converting industry to coal-fired power plants to cutting back automobile fuel consumption to insulating homes and factories. Indeed, the progress has been quite startling, even to many critics.

Moreover, apart from the nebulous symbolism involved, experts agree there's little real evidence that the energy bill now stalemated in Congress would do very much to accelerate that process. The one major provision that might have cut oil usage even modestly—the crude oil equalization tax the president proposed—is dead, and even that wouldn't have cut imports very dramatically.

The single most important force behind this conversion has been the sharp rise in energy prices over the past 3½ years. Despite controls, average prices of domestic crude oil have risen 10 percent a year, while the average retail price of natural gas soared 88 percent in the three years ending last July. As a result, Americans have cut consumption significantly.

Moreover, legislation already on the books from previous years has prodded industry and consumers into conserving further. The Energy Policy and Conservation Act of 1975 mandated relatively stiff mileage standards for U.S. automobiles and trucks, while controls set by the 1974 energy act have prodded utilities and industry into significant coal conversion.

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*From the Washington Post, March 19, 1978, p. E1, E10. © 1978 The Washington Post. Reprinted by permission.

Alan Greenspan, former administration chief economic adviser, argues that, while the effort still is not enough, "people just don't recognize what's happened" as a result of these increases in energy costs. "Some very significant action already have been taken," he says. "It's simply not true that we aren't doing anything about the problem."

The extent of the nation's turnaround from pre-1973 days is best shown by comparison with the president's program. The major aims of Carter's energy plan of last April were to raise prices and spur utilities and industries into converting to coal, improving auto fuel efficiency, broadening insulation of homes, spawning more nuclear power plants and encouraging new exploration.

While none of these proposals has become law, figures show the U.S. already has made significant progress in most of these areas (except for construction of nuclear power plants, which has become entangled in regulatory red tape). The shift, which began two years ago, is just now beginning to produce results.

There are these developments:

Conversion of utilities and industry from gas and oil to coal has gone along at a fairly rapid clip. The National Coal Association says hundreds of utilities have shifted back to coal in the past two years, and 241 new coal boilers are now on the drawing boards. Boiler industry officials report not one oil- or gas-fired boiler has been ordered since late 1975.

In basic manufacturing industries, the shift has been less dramatic, but still visible. In 1974, some 80 percent of all new boilers ordered were oil- or gas-fired compared with only 20 percent for coal or waste fuel. Last year, the orders were for 40 percent oil- or gas-fired and 60 percent coal or waste fuel. Moreover, industry leaders say the trend is likely to accelerate.

Despite suspected padding in Environmental Protection Agency mileage estimates, there's little doubt the auto industry has shifted to more-fuel efficient cars and trucks than before the 1973 oil embargo—and that buyers are more conscious of gasoline consumption. The major auto makers now offer a larger selection of small cars—a sure sign of a growing market.

Americans' push to insulate their homes has been so intense that there now is an acute shortage of insulation materials—a situation that has sent prices soaring and, in too many cases, forced buyers to turn to inferior products. Indeed, the home insulation industry has asked Congress not to pass an insulation tax credit for fear of exacerbating the situation

Conservation of electric power and other energy by industry and consumers has improved significantly in the past few years. Reports from around the country show manufacturing firms as well as private citizens are becoming more conservation-conscious. People are finding there are significant savings in cutting consumption. And they're responding in kind.

The one snag is in the shift to nuclear power plants. Mainly because of heavy restrictions and regulations, construction of nuclear plants has gone more slowly than many officials had hoped. But industry projections still show nuclear power likely to triple its share of electric power generation by 1985. Solar energy, still minuscule, is coming along faster than expected.

Finally, new exploration for energy has been increasing steadily, if not quite at the crash pace some planners had hoped for in previous years. Industry statistics show operation of new rigs at historically high rates, and recent increases in natural gas prices have spurred new exploration there. Experts say it's unlikely either will taper off very soon.

The results of all this have been fairly dramatic. While the nation's economy has grown by some 13 percent since 1973, demand for petroleum has increased only at about half that pace—7.1 percent. On a day-to-day basis, petroleum demand now is running at about 17.5 million barrels a day, on a seasonally adjusted basis—virtually unchanged from its levels in 1973.

The widely cited high level of oil imports now plaguing the nation's foreign trade deficit is mainly the result of higher prices, not import volume. U.S. oil imports are up 23 per cent since 1975. But this year, imports are running at about 8 million barrels a day compared with 9.9 million barrels in 1977, when the country was plagued with a severe winter.

And analysts at Data Resources Inc., an economic consulting firm, project that, because of the shift to more-fuel-efficient cars, demand for gasoline in this country will remain at present levels through 1980—even though Americans will be driving more miles each year. That means, in effect, that consumption levels will slow markedly.

The question is, what, if anything, would the pending energy bill do to speed this process? Not very much, according to both administration and congressional energy experts. Although the bill in its present form does contain some modest incentives for coal conversion, it has little to prod industry beyond what already is taking place.

Even if the bill had been enacted in the form Carter proposed, estimates by private consultants show it would have saved less than 2 million barrels a day by 1985—not a very dramatic difference. (The president originally predicted his plan would save 4.5 million barrels a day, but that's been pared since, both by the administration and outside experts.)

The main value of the pending energy bill now would appear to be mostly symbolic—both to end existing uncertainty over what the government plans to require from industries and consumers and to show foreigners that we really do care, after all. Both, arguably, are worthwhile and important functions. In fact, however, the bill would only be consecrating what already is under way.

Admittedly, the conservation effort now in progress isn't adequate by some planners' standards. Most experts agree the U.S. still needs to do more, and that greater conservation will be required if the nation—and the world—are to avoid a serious pinch in future years. But to say the U.S. hasn't done anything to solve its energy problem simply is dead wrong.

WILL THE REAL ENERGY PROBLEM PLEASE STAND UP?

(By David E. Gushee)*

For more than five years, energy policy has been one of the major issues before Congress. Three successive Presidents have proposed "comprehensive national energy policies"[1] only to see them crumble into bits and pieces when subjected to open congressional debate. Does this mean that Congress is failing? Or conversely, does Congress' reluctance to endorse the proposed comprehensive policies mean that the proposed policies somehow fail to define or address the realities of the energy problem?

The intense debate in Congress and the Nation stimulated by these three Presidential energy policy proposals has revealed three major reasons for congressional concern. First, there is no national consensus on what the country's energy problem is, and on whether the President has characterized it properly in calling it a crisis. Second, the proposals now being debated, like their earlier counterparts, would not solve the energy problem as defined by the President. And third, the proposals would, without solving the problem, significantly centralize in the Federal Government the power to make energy pricing and management decisions currently made throughout the private sector.

DEFINING THE ENERGY PROBLEM

The energy problem is like the proverbial elephant—what it appears to be depends on where you touch it. As in the proverb, there are four generic perceptions of the beast, each of which appears to the perceiver to be the most significant problem and therefore the one to be emphasized in the national policy response. But because the perceivers have hold of different parts of the same animal, they are having great difficulties in communicating with each other on a common basis, let alone coming to agreement on points of contention.

The four generic perceptions are basically concerns about:

1. The Economic Role of Energy;
2. Oil Import Dependence;
3. Oil and Gas Depletion; and
4. The Social Role of Energy.

Everyone in the country is affected to some degree by all four of these concerns, since the four are tied closely to each other in a sort of seamless web. But most do not see the four as equally important; they concentrate on one or another of the four.

The Economic Role of Energy

The U.S. is built, both economically and socially, on the historical presence and the explicit national policy objective of abundant supplies of energy at low, stable, and predictable prices. For generations, and particularly during the past quarter century, cheap energy has substituted for other economic inputs which were more expensive, such as capital and labor. It has also fueled technological innovation, leading to new products, new processes, and new lifestyles. It has increased the number of jobs, workers' productivity, and take-home pay.

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To maintain this economic role of energy, energy prices should be kept as low and as predictable as possible and supplies should be plentiful.

Oil Import Dependence

The U.S. depends on oil for about 50 percent of its total energy needs and is currently importing about 45 percent of the oil used. The trend in oil imports is up, and the trend in dependence on Saudi Arabia for the increment is also up.

This dependence on oil imports has two major types of effects. First are the economic effects—balance of payments deficits and resulting currency-related problems, and the macroeconomic impacts of price increases determined by forces outside the domestic economic system, primarily OPEC. Second are the security effects—reduced independence of action in defense and foreign policy, reduced security of supply.

To reduce oil import dependence, domestic energy production must increase, import volumes must be restricted, or domestic consumption must be reduced.

Oil and Gas Depletion

Domestic production of oil and gas has been declining throughout most of the 1970's. Although more drilling is being done, finding rates are declining enough that new additions to reserves are smaller than production from reserves. Coupled with increasing demand for oil and gas, these trends presage depletion of conventional U.S. oil and gas resources in the foreseeable future and depletion of conventional world oil and gas resources in the predictable future—perhaps one to two generations.

To compensate for depletion of conventional oil and gas resources, other energy sources must be brought into use more quickly than is currently the trend.

The Social Role of Energy

Ever-expanding demand for energy has a number of side effects, many of which are deemed to be negative by one or another group. Air and water pollution, strip mining, concentration of people and economic activity, centralization of energy and other life support systems, and competition for water and other natural resources are among the side effects included in this category. More fundamental, however, is the potential for changed power relationships among the Federal Government, State and local governments, large corporations, and individual citizens.

Dealing with these social effects of expanding energy use implies increased control over the consequences of our energy-related activities, changes in resource utilization patterns, changes in lifestyles, or changes in institutional relations.

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WHICH PROBLEM IS THE ENERGY PROBLEM?

All of these problems are real, although they have different time frames and affect different people differently. Policy options designed to solve one or any of them tend to exacerbate the severity of the energy problem as seen from one or more of the other problem perspectives:

Holding the price of energy down to foster economic health, for example, in effect subsidizes energy consumption, which increases import dependence, hastens oil and gas depletion, delays development of alternative sources, and increases the social impacts of domestic energy production and use.

Reducing oil imports by fiat (quotas or tariffs, for example) decreases domestic activity in the short term, raises domestic energy prices or requires allocation, and increases domestic oil and gas depletion and environmental impacts in the long term.

Converting from oil and gas to coal, electricity, or other alternative energy sources to respond to impending oil and gas depletion increases energy costs, and requires short term increases in oil imports, although it has mixed social impacts.

Pollution control, land reclamation, resource recovery, and waste disposal requirements of increasing stringency all increase costs. Changes in lifestyle imposed more rapidly than the economic costs and benefits would dictate either increase costs or reduce economic activity. Changes in institutional relationships could significantly modify individual rights and the political structure of American society.

Energy conservation has often been touted as the way to avoid counterproductive impacts and thus to avoid the negative effects of other direct actions. Claims for the benefits of conservation are valid, but only up to the point where the energy conservation actions do not lead to counterproductive inefficiencies in utilization of labor, capital, or other resources.

PRESIDENTS' FOCUS ON IMPORT DEPENDENCE

Presidents Nixon, Ford, and Carter have all defined the energy policy problem as primarily one of import dependence. Presidents Nixon and Ford defined the import dependence problems as loss of domestic control over domestic energy prices, reduced freedom of action in defense and foreign policies, and reduced control over oil supply security. President Carter has defined it as a future supply and price cruch by focusing on a projected inability of world oil production to keep up with world oil consumption by 1985 or thereabouts.

All three Presidents sought to demonstrate that the various consequences of import dependence are intolerable and will get worse, in order to justify the impacts of their proposed actions on the economic role of energy, rate of depletion of domestic resources, and social factors such as increased Federal power over States, corporations, and individuals. The Congress has reacted over the years by creating a Strategic Petroleum Reserve, increasing energy research and development, setting auto fuel economy standards, fostering increased energy conservation, supporting more extensive State energy planning, and creating the Department of Energy, among other things. But it has been cautious in granting additional powers to the Executive Branch, has limited the Federal financial commitment to energy supply and conservation initiatives, and has restrained domestic energy prices.

Clearly, the Congress has concluded that the import dependence problem, though real, does not warrant a response akin to the "moral equivalent of war."

IS THE IMPORT DEPENDENCE PROBLEM CRITICAL?

The three major Presidential proposals for a comprehensive national energy policy have defined the energy problem in a 10-year context. In the current case, President Carter has specified the probable development of price and supply instabilities in or about 1985 as the basis of the need for urgent action.

The President's energy analysts, and most others, approach world oil supply and demand questions via the "energy gap" methodology. They assume future world economic growth rates mostly on the basis of the economic plans and objectives of other nations. They then extrapolate demand under a range of price assumptions, most of which are not far from "constant in constant dollars throughout the period of analysis." They assume ranges of energy conservation impacts close to those of recent experience.

On the supply side, they examine each country to estimate domestic energy production capabilities, from which they calculate domestic energy demands that cannot be met domestically. These demands, adjusted for small amounts of LNG and other fuels, are then assumed to be met with imported oil. All the national oil import requirements are added up to generate the world oil demand, which is then compared against OPEC production capabilities.

This approach underestimates feedback among energy price changes, economic growth rates, and energy demand growth rate. A major reason for this might well be the undesirable political consequences of forecasting economic growth rates lower than those required to meet the various national economic objectives.

A growing number of economists are nonetheless challenging the energy gap forecasts. It has been difficult for them to rebut these forecasts, however, because their own macroeconomic models are not much better when applied to forecast periods of such length—up to 10 years.

Over the past several months, economists' forecasts for world economic growth have become increasingly pessimistic for the period 1979–80, the only forecast period for which macroeconomic models can make a reasonable case for accuracy. Although this increasing pessimism is based on lower than predicted growth in the Western world over the past couple of years and on economic factors such as investment rates, incompatibilities between the economic objectives of West Germany and Japan, on the one hand, and the U.S. and other oil-importing countries, on the other, inflation and unemployment trends, trade patterns, currency flows, and the like, today's higher energy prices also play a major role.

Since energy demand over the short term is determined primarily by the level of economic activity, the increasingly pessimistic economic forecasts imply a slackening in oil demand compared to the demand levels forecast with the energy gap methodologies. This slackening is already taking place, as is demonstrated by the current soft oil market and the OPEC decision in January 1978 not to raise oil prices. The soft market has been made even softer by the increasing flows of Alaskan and North Sea oils.

The Administration predicts that recovery from whatever economic slowdown develops in 1979–80 will again take the shape of earlier economic recoveries and that energy demand will follow suit. But this view, too, is disputed by some economists, who hold that current higher energy prices will prevent a return to the earlier growth rates achieved when energy prices were lower. According to this school of thought, the dampening effect will take a decade or longer to work itself out through new technologies and other economic adjustments.

Another factor is the rate at which higher energy prices will cause lower energy consumption at a given level of economic activity. This question, too, is controversial, with data available to support the views of both optimists and pessimists. Preliminary estimates of U.S. performance in 1977, for example, vary considerably, with some showing a significantly lower energy demand growth rate for the equivalent GNP growth rate than others. As these preliminary estimates are refined over the next several months, this question will become somewhat clearer, although much room for argument will remain.

In sum, evidence for a world energy supply crunch in the 1980's is not convincing and is getting less so. Evidence is also mounting that the probability of significant economic problems within the next couple of years is getting higher and higher. As will be discussed below, the Administration's most controversial energy proposals have the net effect of either hurting the economy or being neutral to it over the short term, which is the period in which economic problems already threaten. No wonder, then, that Congress is finding a range of problems with the President's Plan, particularly with those parts which have the most serious negative economic impacts over the short term.

WOULD THE NATIONAL ENERGY PLAN SOLVE THE PROBLEM?

The President's National Energy Plan estimated that oil imports in 1985 would be reduced by about 4.5 million barrels per day from the level that would be reached without the Plan. This aspect of the Plan has been universally challenged—by the Congressional Research Service, the Congressional Budget Office, the General Accounting Office, and others. The censensus of these analyses was that there would be much less impact on oil imports than was claimed, because domestic energy production would probably not be as high as was estimated in the Plan and the conservation and conversion programs would be much less effective than was claimed.

The Administration has not effectively rebutted these challenges. It has maintained, however, that the Plan's initiatives are still necessary for the long term and that their passage by Congress would move the country in the right direction while also helping to strengthen the dollar compared to other currencies. The Administration recently

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granted that there is a danger that expectations of what the energy bill might accomplish in reducing imports and consumption may be too optimistic but claimed that the bill is needed as a demonstration of political will.

What is frequently overlooked when talking about political will, however, is the fact that congressional action in the 93rd and 94th Congresses has already put in place programs to accomplish most of the objectives of the Plan, although by different means in a couple of key areas. What is at stake in these key areas is much more where the money and power flow than where and how much energy flows.

The first key area remaining in dispute is natural gas. The Administration has proposed bringing intrastate gas under control (it is currently not controlled), setting the price for new gas at a level higher than the current interstate price but lower than many existing contracts in the intrastate market, and directing all increased gas costs to industrial and utility consumers for the next several years. This issue does not relate to conservation of natural gas through 1985, since all that can be produced will be sold regardless of price (at least up to the world oil price) but its resolution will affect the amount of new gas produced and the revenues to gas producers.

The second key area is the crude oil equalization tax (COET). This proposal would impose a tax on crude oil to bring its acquisition cost to domestic refiners up to the world oil price despite the continued control on the price the domestic oil producers would receive. Should COET be enacted, revenues will flow to the U.S. Treasury that would, under current law (Energy Policy and Conservation Act, Public Law 94–163, as amended), flow to oil producers, although on a somewhat different schedule. This proposal has the potential to conserve a relatively small amount of oil, would significantly increase Federal Government revenues, reduce oil industry profits, cause some increases (of uncertain size) in the prices of oil products, and keep the Federal Government involved in oil industry pricing decisions whereas under existing legislation (the Energy Policy and Conservation Act as amended) the Government would be phased out of control.

The third key area is the oil and gas users tax designed to stimulate conversion of utilities and industry from gas and oil to coal by making gas and oil more expensive. It would operate in conjunction with an expanded regulatory program, from which industry and utilities can escape on economic grounds. With the tax, the economic grounds would apply to fewer installations than without the tax. This tax could have a significant impact on the amount of oil used.

These three key proposals in continued dispute all have negative economic impacts: they all raise energy costs. The first two, as proposed, also reduce the amount of revenue accruing to domestic oil and gas producers compared to continuation of current policies. The third takes money from industrial oil and gas consumers which, even if rebated for capital-intensive coal-related investments, leads to increased industrial fuel costs.

Thus, all three key controversial proposals have negative effects on the economic role of energy and neutral, modest, and significant impacts respectively on oil imports through 1985. Further, all three increase the Federal presence in private sector decision-making compared to current policies and thus relate to the socal role of energy.

Clearly, the more critical the energy problem is perceived to be, the more willing Congress will be to deal with the economic and social factors involved, provided that resolution of the issues would in fact help to make the energy problem substantally less critical. On this basis, it is not surprising that the Senate version of the oil and gas users tax, which would limit the negative economic impact of the tax compared to the House version, and still have a meaningful impact on oil imports, has more driving force behind it than the House version.

Another major issue yet unresolved in the Congress is the nature and extent of tax incentives for both industrial and consumer investments in conservation and conversion. Since these are economically stimulative, in contrast to the other three issues, they are more likely to receive positive consideration. The major issue is the extent to which they should be applied, in light of their efforts on the Federal deficit directly and inflation somewhat less directly.

Since the immediate driving force for enactment of the energy package has been shifting away from solving the energy problem to helping to solve the problems of international credibility and the falling value of the dollar in international money markets, then some version of these tax incentive proposals has a good chance for passage either as part of the energy package or as part of the economic stimulus package currently under congressional consideration.

CHANGING THE PERSPECTIVE

For the past five years, the energy problem has been posed by Presidents to Congresses as a critical import dependence problem requiring actions whose impacts on economic and social values are justified by the criticality of the problem. So far, those affected negatively have succeeded in preventing a massive national response to the import dependence problem on the inferred basis that the impacts in other areas created by such a response would be more critical than the impacts of the problem being attacked.

This conflict among economic, social, and security values is certainly real, as the recession of 1974–5 and the current slide of the dollar, among other things, show. But it is intensified by attempts to deal with the import dependence problem more rapidly than the economic system can respond to efficiently and by methods that would change the relationships between the Government and its citizens. Putting the problem in a 10-year context, and looking for a solution that can take effect that quickly is thus having the effect of making a real problem worse without offering much hope of making it better.

Over the next quarter century or so, the current import dependence problem will be resolved through increases in the price of energy phased to permit the American and world economic systems to adjust. One difficulty with this concept is the fact that today's world oil price is high compared to production costs in Saudi Arabia and is held there by a cartel. Another difficulty is the technological optimism that predicts that alternative sources of energy, once on line, will be produceable at costs near, or perhaps even below, today's world oil price. The former consideration is probably academic, since there is little likelihood that OPEC will reduce its oil prices. The latter consideration is a straw being grasped at in hopes that the economic role of energy need not change in the future.

The world is in transition between an era of cheap plentiful energy and an era of expensive plentiful energy. Cheap energy has been available for the past century through exploitation of conventional oil and gas resources. The end of these conventional resources is in sight, which is the basis for oil and gas depletion argument and one reason why OPEC feels justified in raising their price now even though production costs in the major world fields are still relatively low.

There are equivalent energy resources around the world in the form of unconventional oil and gas deposits (tar sands and shale for oil, geopressured waters and Devonian shales for gas, for example), coal, uranium, and the sun's energy in its various forms.

These cannot compete against conventional oil and gas for the simple reason that, with known or foreseeable technologies, they are harder to turn into useful energy forms than are oil and gas. They will become economic when conventional oil and gas become scarce enough for one or more of these alternative sources to become the cheapest sources at the margin. But when they become economic, they will be plentiful both in absolute size of the resource and relative to demand at the prices necessary to bring them forth.

Although one can't be sure how expensive these sources will be when they are the cheapest incremental sources of energy, it appears now that taking into account environmental protection requirements, they will cost from two to three times as much as today's world oil price in today's dollars. Since today's world oil price is about four times its pre-embargo price, this means a transition to energy sources of eight to 12 times those in force when our economy was built.

Thus, in the long run, it is the economic role of energy which must change. It is changing already in response to today's oil prices. Further, since the U.S. cannot supply itself with oil and gas in the volumes demanded at today's world oil prices, and since plentiful alternatives do now and will continue for a rather long time to cost more than world oil, the import dependence problem and the conventional oil and gas depletion problem can only be solved through this change in the economic role of energy. But since the economic role of energy is a major factor in overall U.S. economic health, the rate of adjustment is limited by the extent to which the country can engage in uneconomic activities designed to stimulate production of alternative fuels and conserve beyond the point of economic optimization.

This question of the pace and nature of economic adjustment and who will lead it is what debate over President Carter's National Energy Plan is all about.

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FACT SHEET: PHASE TWO ENERGY PLAN—A SUPPLY STRATEGY

(By Sarah Glazer)*

The policy office of the Department of Energy is in a frenzy of activity reminiscent of the days when President Carter's national energy plan was being pieced together. This time the work is on a sequel: a supply strategy. In its present very preliminary form, the strategy emphasizes federal subsidies for development of synthetic oil and natural gas from coal and oil shale.

The department originally had planned to introduce its so-called National Energy Supply Strategy (NESS) in the spring of 1979, with a detailed study preceding it this fall. The strategy will meet the legal requirement the administration has to update the national energy plan. It also will provide a comprehensive look at the nation's future needs for energy supplies and make proposals for government action.

But by a fluke of history—and congressional pressure—Energy Secretary James Schlesinger has pledged publicly to give Congress a first look at the supply strategy by May 1.

The department had just started to organize into supply task forces when Schlesinger was questioned Jan. 25 by members of the House Science Committee on his department's plans for assuring the country sufficient supplies of energy. Schlesinger replied that his department would have something up to the committee within 90 days.

The secretary instructed his staff to prepare a list of supply initiatives to be sent to the Science Committee in the form of a 25-page memorandum. Assistant Secretary Al Alm's Policy and Evaluation office is organizing the effort, which includes staff contributions from all quarters of the department.

In a meeting with Schlesinger shortly after his promise to the Science Committee, Alm's staff drew up a "wish list" of supply initiatives. The list is heavily weighted toward various forms of federal subsidies for developing synthetic oil and gas from coal and synthetic crude from oil shale.

However, so-called "soft" technologies, a term for renewable resources with decentralized application such as solar and wind energy, are on the list.

Energy conservation, which played no part in the early department discussions of the supply strategy, has since been added to the wish list. A task force has ben assigned to concentrate on conservation initiatives that could contribute to increased supplies.

How Congress will react to the upcoming proposal is uncertain. For one thing, it will be somewhat limited in scope, containing only those ideas already studied by the Energy Department. Yet, some of these ideas will constitute major new, and potentially explosive, initiatives for Congress. For another thing, the proposal will not be very specific and will not be in legislative form.

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*Sarah Glazer is a member of the Environmental Study Conference, an informal and impartial bipartisan legislative research organization made up of 300 members of the House and Senate. The fact sheet appears in the Congressional Record, Feb. 27, 1978, p. S2430–32. Reprinted by permission.

Still, members may seize on the proposal to boost certain programs. And the administration itself apparently is considering certain budget amendments, such as boosting fossil energy R&D, to meet some of the initiatives in the upcoming proposal. Budget reprogramming proposals for fiscal 1978 and 1979 also may come out of the administration.

However, in view of the already heavy legislative workload and this fall's elections, Congress appears unlikely to start moving any major new legislation this session.

Besides the Science Committee, DOE probably will send its proposal to other House energy committees and the Senate Energy Committee.

Another aspect of the department's work on this spring's proposal is a study of how much energy will be needed in different sectors of the economy between now and 1990. The department's computer is running through both original and secondary data to look at the problem.

The goal of the supply strategy is to eliminate domestic dependence on oil imports. The national energy plan called for a reduction in oil imports to seven million barrels per day by 1985. The supply strategy supposedly would reduce imports to close to zero.

The department sees the scarcity of liquid and gaseous fuels as the crucial problem arising in 1985 to 1990 and thus proposes programs to develop domestic oil and gas sources by that period.

The department's main premise is that oil prices will probably double by 1985—up to about $25 per barrel. This figure was originally postulated by Deputy Energy Secretary John O'Leary. If this price is reached, DOE assumes that synthetic fuels, which are now uneconomical, could be competitive by 1985.

If world oil reaches $25 by 1985, a January DOE memo noted, "we should be willing to guarantee up to 25 dollars/barrel" for synthetic liquid fuels or $4.50 per thousand cubic feet for gas from unconventional sources.

PROJECTS UNDER CONSIDERATION

The department has divided work on the supply initiatives into about a dozen task forces. In addition to conservation, task forces are studying at least another eight technology areas. In addition, the department is looking at areas that cut across technology lines, such as impacts on the environment and economy.

The tentative proposals being considered are outlined below. The information comes from a DOE memo summarizing a January 27 meeting with Schlesinger on the supply initiatives memo.

Many proposals may be dropped or added before this spring. At press time, however, knowledgeable department sources said it still represents the rough outlines of current thinking.

Solvent Refined Coal

DOE would build one demonstration plant by 1982–1983 in the so-called SRC method, which produces a low-sulfur solid or liquid material from coal. The plant would produce about 20,000 barrels per day.

Under consideration for a possible demonstration plant is a proposal by Gulf Oil Corp. to use the SRC method. However, Gulf's product may be too expensive, perhaps more than $30 per barrel.

Synthetic Fuels

According to the memo, regulatory measures could be used to require 5 or 10 percent of all petroleum products sold to be from unconventional sources, such as synthetic fuels and alcohol, by some target date in the future. This method could save up to 600,000 to 700,000 barrels of imported oil per day by 1990, administration staff estimate.

Issues raised by this option would be how to handle imported products, how to guarantee some form of equity among producers and the time for phasing in the regulations.

One thought is to institute an entitlements program along the lines of the current program that distributes nationwide the high cost of foreign oil among domestic refiners. For refiners dependent on expensive foreign oil, the current program gives a credit for the price difference between lower priced domestic oil and foreign oil. Those areas that use mostly domestic oil must pay the difference between the domestic and world oil price. High-level officials are considering plugging high-cost synthetics into the equation. The effect would be to average high cost synthetic liquids into the cost of all oil.

Oil Shale

The government would guarantee prices to oil shale companies. Competitive bids could ensure that the guaranteed price would be as low as possible.

Oil shale might also be included in the proposed 5 to 10 percent requirement for unconventional liquids in the petroleum supply.

Oil shale, a combination of "marlstone" rock and an organic material called kerogen, produces a crude oil product when heated to very high temperatures. The richest reserves are located in Colorado's Piceance Creek Basin, below the western slope of the Rocky Mountains.

Synthetic Gas

One proposal envisions federal guarantees of loans for five large plants totaling 250,000 barrels per day in capacity.

Issues include whether to go with loan or price guarantees, the policy for liquefied natural gas, and what regulatory authority the administration has to take action in this area.

Unconventional Gas Sources

This would include expensive, exotic sources of natural gas such as geopressurized methane. Possible proposals include price guarantees of up to $4.50 per million Btu (British thermal units) by competitive bid for a set capacity and a government drilling demonstration program. Unconventional gas could be included in a program like that suggested for synthetic fuels, where a percentage of pipeline gas would have to be unconventional.

Soft Technologies

Proposals under consideration would include accelerated R&D programs and building demonstration plants to turn waste—such as wood chips—into energy and community-scale heating plants.

Among the options under most active consideration are alcohol from biomass (i.e. waste products like grain), direct burning of garbage for electricity, small-scale hydroelectric plants and wind energy.

Special concern is focused on which of these options would substitute most effectively for scarce oil and gas.

Industrial Coal Program

A number of incentives are under consideration to promote three technologies to cut down air pollution from coal burning. Included is atmospheric fluidized bed combustion, a process which eliminates through a chemical process most of the surfur from coal as it burns in a limestone bed. Another candidate is scrubbers, the prime technology now used to cut emissions in the stack. The third is coal-based gas with a low heat content, also known as low-Btu gas. Low-Btu gas is an industrial fuel. It is not practical for use in pipelines because of its low heat content, but is useful for generating electricity.

Incentives under consideration for these technologies include:

A tax credit or fast write-off

A regulatory program requiring either direct burning of coal or a choice of the above technologies

A federal purchase subsidizing one third or one half the cost of installing the above technologies.

An important issue is how such a program would relate to the national energy plan—particularly the portions requiring industry to convert to coal and encouraging conversion through taxes. The regulatory conversion portion has been approved tentatively in conference. Additional legislation may be needed.

MEDIUM-BTU GAS

Also under consideration for federal subsidies is synthetic gas from coal with intermediate heat content (between the heat content of natural gas and low-Btu gas). Medium-Btu gas is considered unsuitable for pipeline transportation, but can be useful for heating and for industry near the site of production.

The proposal would pay 25 to 50 percent of the cost of the first few years of projects for use in industry complexes or in heating plants on a community scale. Administration staff note that subsidies may be tricky for this proposal because community programs are complicated.

THE CONGRESSIONAL OUTLOOK

Perhaps the most frequently heard congressional criticism of President Carter's national energy plan was that it focused on energy conservation, without enough emphasis on increasing new sources of supply. The administration defended its approach by saying conservation is a cheaper source of supply than actual production, but opponents never bought the argument.

Demands for supply initiatives, in fact, may spell death of the pending energy package, which has languished since Christmas. Sen. Long (D-La.), chairman of the Senate Finance Committee, proposed to turn the revenues from the administration-proposed crude oil tax into a trust fund for producer incentives. Carter originally proposed to rebate those revenues to consumers. A vigorous floor fight is expected if this issue ever reaches the floor again.

Long is a key factor in the conference on the tax portion of the national energy plan. The conference is not expected to reconvene until conferees on the natural gas portion of the plan have reached agreement. Even if agreement is reached on natural gas, however, Long's staff is proclaiming the plan politically dead. Congress is not likely to vote for Carter's tax increases by the time they reach the floor—close to campaign time.

There is some speculation that the administration sees supply strategy as a lever to get the Congress moving again on the energy package. But the ploy probably will not work unless the administration shows a willingness to be more flexible than it was the last time around. The administration has continued to insist that all five bills in its energy package be passed together—or not at all—even though three of the five bills are close to congressional approval.

THE REAL PHASE TWO

The Energy Department is still planning to go ahead with its plans for developing a comprehensive supply strategy, although the sudden gearing up for the "eight-week wonder" could throw off its original schedule. The policy office is shooting for the end of March to send a draft to Schlesinger.

As part of this long-term process, the department plans to rectify some of the mistakes of the past. In particular, it plans to reach out to Congress and outside groups. By May 1, administration staff promise, they will have started a process for bringing in outsiders for suggestions.

The promise has not proved reassuring to the environmental community which is already up in arms over the way phase two is being handled.

The Natural Resources Defense Council, an environmental law firm. has written to Schlesinger urging him to establish briefings and meetings for public involvement immediately. NRDC also is urging that the department prepare a draft environmental impact statement to accompany phase two through the decision-making process.

"One of the great failures of NEP (national energy plan) has been its hasty and basically internal development, resulting in no discernible constitutency which is prepared to work for its passage" NRDC declared in its Feb. 17 letter. "It would be the height of folly to repeat those mistakes in developing phase two."

Even as members of Congress are urging quick results on an energy supply strategy, NRDC, the Sierra Club and other environmental groups also are pushing a go-slow approach. They would prefer that the department study long-term needs and initiatives in an orderly fashion.

A more deliberate pace would probably help the role of "soft technologies" such as solar energy. A high-placed DOE official working on this section of the supply strategy noted that there is less information right now on the contribution that renewable technologies can make to the nation's supply than there is on other energy sources. As a result it is hard to justify proposals for federal help in these areas with only eight weeks of preparation.

Environmental groups have expressed great concern over the short shrift that the supply strategy seems to be giving to renewable technologies. Some have termed the new proposal former Vice President Rockefeller's "Energy Independence Authority warmed over."

In the past, environmental groups have fought federal subsidies for synthetic fuel development. They have argued that federal loan guarantees, for example, will divert investment in a capital-short market from more environmentally desirable energy sources.

Proponents of loan guarantees have argued that federal backing is necessary to answer investors' doubts about the viability of coal gasification and oil shale development. Environmentalists answer that if the projects are so risky, the government should not subsidize them.

There are numerous environmental problems associated with oil shale and coal gasification, both of which are expected to lead to extensive strip mining in the West. In addition, the processes require vast amounts of water in areas where water is already scarce for agricultural and other uses.

At least some segments of the department are pushing oil shale as the most economical contender to replace oil imports. The government controls 80 percent of the shale-bearing lands in the nation, and some government estimates say oil shale can be produced at $10–17 per barrel.

One DOE memo calls oil shale's environmental problems "difficult" but "not insurmountable if the western region has the political will to develop" the resource.

Environmental groups would disagree with this assessment. Oil shale ranks as the least favored synthetic fuel of the Environmental Policy Center, the environmental group that has been most active in the synthetic fuels debate.

The richest oil shale lands are concentrated in Colorado in what some consider the most magnificant natural part of the state. Since it takes a lot of shale to produce a barrel of oil, the technology would produce vast amounts of unused waste rock, which would have to be disposed of in canyons or valleys.

PART TWO

Resolved: **That the Federal Government should exclusively control the development and distribution of energy resources in the United States**

. . . Federal energy policy in the past . . . has relied to the maximum degree on private enterprise to make the major investment, development, and pricing decisions affecting energy supply . . . .—*Frances A. Gulick*

The President's proposals would, without solving the problem, significantly centralize in the Federal Government the power to make energy pricing and management decisions currently made throughout the private sector.—*David E. Gushee*

. . . the normal functioning of our economy will not . . . produce the capital investment required to fully develop alternative energy resources within a reasonable period of time . . . .—*Vice-President Nelson A. Rockefeller*

Perhaps a federal company that competed with the private companies in exploration for oil and gas could do a better job of discovering new reserves, thereby increasing domestic supplies at lower cost . . . .—*Robert Pindyck*

As each level of government begins to take more extensive energy action, the issue of the division of state and federal authority becomes more complex. . . . either cooperation must be generated or conflict will ensue. . . .—*Jon Mills and R. D. Woodson*

[Coastal zone] law seeks to reconcile what is inherently irreconcilable—the many conflicting public and private interests that are pushed and pulled in a giant tug-of-war within and among three competing levels of bureaucracy: federal, state, and local . . . .—*Conservation Foundation*

Unfortunately, judging from federal leasing trends of the past ten years or fifteen years, consistent and rational policies are either nonexistent or, if they exist at all, they don't reflect any effective management . . . .—*Courtland Lee and David Russell*

In order to adequately determine the extent of all of America's energy resources, the Federal Government may find it necessary either to undertake to directly determine the size of these reserves, or to provide incentives for private industry to commit capital and manpower to the task under some sort of mandatory reporting procedure . . . .—*From Petroleum Industry Involvement in Alternative Sources of Energy*

The effort to break oil companies up seems to have lost its impetus. Therefore, the best way to check their growth and their alleged power seems to be to keep them out of, . . . other forms of energy . . . . —*James Flanigan*

The comprehensive national energy policy that most professional economists . . . appear to favor is one which limits government intervention in resource allocation to correcting for clearly demonstrated significant externalities. Otherwise, the market, not government, should be allowed to allocate scarce resources among competing ends. —*Walter J. Mead*

A. The Energy Independence Authority

STATEMENT OF NELSON A. ROCKEFELLER, VICE PRESIDENT OF THE UNITED STATES*

Vice President ROCKEFELLER. Mr. Chairman, distinguished gentlemen, I am very grateful for this opportunity to appear before your committee. I think perhaps I would do better going through the prepared text first and then come to some of the very provocative statements or questions to which you wish to get an answer. So perhaps I will just go through this to give it a backdrop and then make a few comments on the questions . . . .

I appreciate this opportunity to join with you to discuss the most challenging problem of a challenging era—the energy crisis.

First, I would like to ask, and then answer, the following questions: (1) Is there really an energy crisis? (2) What happens if we just continue as is—to depend on increasing foreign imports to meet our Nation's growing energy needs? (3) Do we, as a nation, have the resources and capacity to achieve energy independence? (4) What does it take to do it? (5) Why does government have to get into it?—Why isn't private enterprise doing it? (6) How can government play an appropriate role in achieving energy independence without subsidizing private interests, or without interfering with the free enterprise system? (7) If the answer to getting us off dead center is an Energy Independence Authority, as provided for in Senate bill 2532, how would it work? (8) With an all-out national effort, how fast can we expect to achieve the goal of energy independence?

I. IS THERE REALLY AN ENERGY CRISIS?

Unfortunately, many Americans do not believe the energy crisis is real because there is no tangible evidence of it. There is gas in the pumps and the lights go on when they flip the switch. They recognized it 2½ years ago during the Arab oil embargo when the lines formed at the service stations. But there are no lines now because we are importing 40 percent of the oil consumed in this Nation.

In 1960, we received 18 percent of our oil from foreign sources. During 1 week last month, our foreign oil imports reached more than 50 percent of our total consumption. Even more alarming is the fact that the proportion of our imports which comes from unstable Mideast sources is rising faster than the growth rate of our imports as a whole.

While imports rise, domestic production in both oil and natural gas is declining. The Northeastern part of this country is now dependent upon foreign sources for 73 percent of its oil. If this supply were suddenly cut off, there would be social and economic chaos.

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*Given before the Committee on Banking, Housing and Urban Affairs, United States Senate, Apr. 12, 1976, pp. 2–9.

Should we have another embargo, the economy of this country would be shattered. Today's energy situation is, in my judgment, a clear definition of a crisis.

II. WHAT HAPPENS IF WE JUST CONTINUE AS IS—TO DEPEND ON INCREASING FOREIGN IMPORTS TO MEET OUR NATION'S NEEDS?

Between now and 1985, our energy needs will grow by 36 percent. If we continue our current course, and continue to regulate oil and natural gas prices at current levels, if we do not develop our current reserves, if we fail to increase the generating capacity of nuclear plants, if we do not adopt a strong program of conservation, and if we fail to commercialize new sources of energy, such as gas and oil from coal and shale, we will be importing between 50 and 60 percent of our oil in 1985. And it will cost us in foreign exchange not $30 billion, as it will this year, but $50 billion by 1985. It is obvious what a threat of an embargo would do to our national security and defense capabilities under such circumstances as well as to our capacity to meet our responsibilities to the other nations of the free world who, without our protection, would be equally vulnerable. I am hesitant even to speculate on the kinds of economic, political, and military pressures that could be imposed on this Nation if we continued to be more than 50 percent reliant on foreign sources.

With such a large amount of the oil coming from one area of the world, the supply lines provide a tempting opportunity for the Soviet Union, with its growing sea power, to disrupt the transport on the high seas. But there are other serious consequences that could result. The continued dependence upon foreign sources of oil could cause us to lose credibility with our allies. They would be justified in asking whether or not we would support their interests against those of our oil suppliers. Our continuing dependence on imported oil threatens our ability to maintain our leadership in the free world, our economic well-being and our national security.

Now, let's look at what happens to our economy, if we continue along our present path of depending on increasing foreign imports to meet our Nation's growing energy needs. In 1973, we were spending $4.3 billion annually for foreign oil. And in 1976 we will spend $30 billion. We now export $22 billion in agricultural products—which is up from $8 billion in 1973. Were it not for the sale of these farm products and the sale of $10 billion worth of arms, we would not have maintained our balance of payments.

On the other hand, if we just continue on the present course, we will be spending up to $50 billion overseas for imported oil to meet the growth in our domestic needs. On the other hand, if we were to spend the $30 billion at home, it would provide jobs for at least 1,200,000 people. And, by 1985, $50 billion spent at home to produce our energy requirements domestically would produce close to 2 million jobs for American workers.

If we don't follow this course, at some point, the economics of business will compel industrial concerns to locate their facilities in close proximity to energy sources abroad, rather than to their markets and customers at home. This would mean an additional loss of jobs in this country and would be detrimental to the vitality of the entire American economy.

As energy costs rise due to the arbitrary action of the OPEC cartel over which we have no control, inflationary pressures are placed on our economy. When this occurs, there is a tendency for government to enact policy which inhibits economic growth. To continue along our present path spells economic, social and political chaos.

III. DO WE AS A NATION HAVE THE RESOURCES AND CAPABILITY TO ACHIEVE ENERGY INDEPENDENCE?

The answer is yes. We are extremely fortunate as a nation to have vast reserves of resources that can be converted into energy. The North Slope of Alaska will make available significant amounts of oil and natural gas. And we have known reserves of coal that will last us for at least 100 years. It is estimated that our shale oil reserves are equivalent to four to five times the total amount of known oil reserves in the Middle East. The potential resources on the Outer Continental Shelf are expected to be substantial. We have the technology and ability to more than triple the generation of nuclear power with appropriate safeguards by 1985. We have, in this country, potential energy from geothermal, solar, and other sources. All of these can replace our dwindling present domestic supply of natural gas and oil—in a way that protects our environment.

To achieve energy independence in this century, we must develop and construct the facilities necessary to exploit these new sources and we have already lost 2 years in getting started.

IV. WHAT DOES IT TAKE TO DO IT?

To achieve energy self-sufficiency we must, in the short term, face up to the issues that confront this Congress and the American people. We must enact and employ conservation measures. We must deregulate the prices of domestic oil and gas. We must assure that we do not unduly impede the development of nuclear power. And we must assure that our environment is protected, but that the policies we adopt in doing so do not deter the development of our resources, such as coal, oil shale, and offshore oil reserves. There is no problem in achieving both goals if we all work together. Modern science and technology can assure the achievement of both goals together.

According to Federal Energy Administration estimates, if we take all the necessary actions in the next 10 years we can reduce our energy needs by 5 percent through conservation, increase domestic oil production by 50 percent, increase coal production by 100 percent, increase natural gas production by 10 percent, and increase nuclear power generation by 300 percent. This will require, among other things, deregulation of oil and gas, strong conservation measures, and $600 billion to $800 billion in private sector investment in domestic energy production and conservation. We must restore existing and construct new transportation systems where necessary. In the longer term, we must commercialize known technology for the gasification and liquefaction of coal.

And, as new technologies become known for the development of such energy sources as solar, geothermal, and urban wastes, they can be applied commercially. Energy independence can be achieved from the application of all of these approaches before the end of the century if we have an all-out national commitment.

V. WHY DOES GOVERNMENT HAVE TO GET INTO IT?

Why isn't private enterprise doing it? Energy independence is a national objective that is essential to the economic and strategic well-being of this Nation. Private enterprise alone cannot and will not do it. There is ample precedent for positive Government action to encourage the American enterprise system in achieving national objectives that contribute to economic growth, the well-being of our people, and our national security.

We have a transcontinental railroad system because the Government provided the land. We have a uniquely productive free enterprise agricultural system because of assistance by the Government through the Homestead Act, land grant colleges, the Extension Service, and the Federal Agricultural Credit System. Our civilian aviation industry evolved from the research and development of military aircraft. Because of the billions of dollars spent on our highway system by all levels of Government, we have a prosperous automotive industry which is basic to our economy. All of these are examples of the partnership between Government and industry to achieve an essential national goal which was not attainable by either acting alone.

In the case of energy, we have the raw materials to achieve self-sufficiency. However, the normal functioning of our economy will not, because of the uncertainty of the risks involved, produce the capital investment required to fully develop these resources within a reasonable period of time. Private capital sources are—for good reason—reluctant to make capital available for domestic energy production projects because of the uncertainty of Government regulation, cost and prices. For example, the development of a single coal gasification plant would require a capital investment of up to $1 billion and take approximately 6 to 10 years to construct. Because of the uncertainties of the technology and price and the long leadtimes, such a project has more than just the ordinary risk. Many projects, such as floating nuclear powerplants, railroad reconstruction, or large pipelines, are of such size and scope that financing from the private sector alone may not be adequate. Because the electrical utilities have not been able to raise the financing necessary to construct them, 92 nuclear powerplants have been cancelled or postponed, in large part. They now take 10 or more years to build, cost approximately $1 billion, and the State regulatory bodies will not give a rate increase to finance them until the power from the new plant comes on line; thus, their inability to get private financing.

This is not to suggest that these projects are destined to lose money. It only points out the uncertainties that deter private sector investment. We are not in a position to wait until these uncertainties become certainties. The longer we wait, the further into the future we push the day when these projects will add to our domestic energy production.

VI. HOW CAN GOVERNMENTAL PLAY AN APPROPRIATE ROLE WITHOUT SUBSIDIZING PRIVATE INTEREST, OR WITHOUT INTERFERING WITH THE FREE ENTERPRISE SYSTEM?

Government has traditionally played a role of providing incentives in one form or another to assure that adequate capital is available to the private sector in achieving national objectives. In this case, the

Government's role would be to provide up to a total of $100 billion of risk capital for energy projects essential to energy independence which cannot get the necessary amount of private financing. The Government loans would be on terms comparable to those offered by the private sector. In financing the development of energy resources, the Government program should function like an investment bank or other private sector financing agency—providing assistance to promising projects, but on a self-liquidating basis. This would provide an appropriate Government/private sector partnership which would work together to get this country off dead center in achieving energy independence without a giveaway or subsidy.

The legislation stipulates that the private sector would own and operate productive facilities and not the Government. The American enterprise system has shown itself to be the most efficient and capable producer in the world. By providing financial assistance to take those risks which are beyond the capacity of the private sector, the Government would act as a catalyst in getting the energy independence program into motion.

But after costs were determined and market prices established, then the competitive nature of our system would provide the incentives necessary for the successful achievement of our energy independence goals.

VII. IF THE ANSWER TO GETTING US OFF DEAD CENTER IS AN ENERGY INDEPENDENCE AUTHORITY, AS PROVIDED FOR IN SENATE BILL 2532, HOW WOULD IT WORK?

The Energy Independence Authority would have authority to provide up to $100 billion of financial assistance for energy projects which could not otherwise secure financing from private sector sources. This sum would be raised through the sale to the Treasury of up to $25 billion in equity securities and the issuance of up to $75 billion in Government-guaranteed obligations. The Authority could provide financial assistance in a variety of ways, including loans, loan or price guarantees, purchase of equity securities, or construction of facilities for lease-purchase. The Authority would not be permitted to own and operate facilities, or to provide financing at interest rates which are below those which prevail in the private sector. The Authority would be authorized to support emerging technologies in energy supply, transportation or transmission, and conservation, projects which displace oil or natural gas as fuels for electric power generation, projects which involve technologies essential to the production or use of nuclear power and projects of unusual size or scope or which involve innovative regulatory or institutional arrangements. It is also authorized to finance capital investments necessary for environmental protection. The Energy Independence Authority would be run by a board of 5 directors appointed by the President and confirmed by the Senate.

VIII. WITH AN ALL-OUT NATIONAL EFFORT, HOW FAST CAN WE EXPORT TO ACHIEVE THE GOAL OF ENERGY INDEPENDENCE?

With an all-out effort—based on the establishment of the Energy Independence Authority to assist in financing the short-term actions required to limit our vulnerability by 1985, as well as the new domestic energy sources we will need after 1985—we can achieve energy independence before the end of this century. But time is of the essence. We cannot wait another year if we are going to protect our national security and rebuild our economic strength to meet the needs of our people at home and our responsibilities abroad. The time to act, in my opinion, is now.

Mr. Chairman, if I may comment briefly on a few of the comments you made, you pointed out that the private market was a pretty good jujdge of what was sound, and that if the thing is sound the private market would do it.

The problem we face here is that we are in a situation where the OPEC countries have acted on a political basis, not on a free market basis, to raise their price of oil in the world market. At home, the President has declared that our national policy is that we shall be independent as far as the production of energy is concerned.

Both of these statements—first the action by the OPEC countries and the statement by the President—cut across a free world market. The energy companies, I think many of them, are hopeful that the OPEC cartel will break up and that they will go back to cheap oil. If that is the case, then why bother to spend money for higer cost production here at home, and that's a question, too.

The risks are very great because we have price control on natural gas and price control on oil. Therefore, it's hard to judge, if you produce new sources from new sources, whether your costs are going to relate favorably to controlled prices. We don't have a free market on prices. This concern is understandable because we have been through a period of rapidly rising costs and the Congress has taken action to hold down prices. However, this does adversely affect the free market, and does not support our national security or national well being. Therefore the EIA proposal is devised as a means whereby, during this interim period, an evolutionary period, as we adjust to higher world prices, the government can take those steps which are in the national interest. As and when these steps are taken, the properties would be sold and if there's a profit the government would realize this profit. It would not only get back its initial investment but would get back the additional money which would derive from the profit.

For instance, the production of oil from shale is still an unknown field on a commercial scale. A commercial operation would cost in the neighborhood of $200 million. We have reserves of 4 or 5 times the known reserves in the Arab world. To develop these reserves and find out what those costs would be is very much in our national [illegible]rest. No private company is willing to do it because they don't [illegible]w whether they would lose the $200 million and therefore they [illegible]d rather go somewhere else.

This I think is the kind of thing which the government can contract for, just the way we did under the RFC with the Rubber Reserve Corp., when Jesse Jones set it up. They contracted with, I think, 6 private companies to develop synthetic rubber. Four or five processes were successful, but the whole thing was sold and we developed as a result a new industry in the United States.

This has been the history of this country and as far as the size is concerned, which is the second point you raised, $100 billion in relation to $6 or $8 hundred billion to achieve energy independence, in my opinion, is—in relation to costs today, and it's estimated that in the next 30 years we're going to use $4 trillion of new capital investment to meet the demands for growth—this is not a large amount. It is large in terms of the past, but not large in terms of where we are today or in the future.

So, from the point of view of size, the costs are astronomical in terms of our traditional way of thinking, but I think this is the time for bold action in this country if we want to preserve our leadership both in terms of economic growth at home and in terms of our responsibilities in the world.

So to me this is not one-quarter of our annual budget and it's not federal spending.

As to whether it's a blank check, of course, the definition of a blank check I guess would be a question as to Congress' control over the individual expenditures. In our system of shared responsibilities, as I understand it, the Congress sets the policies, creates the framework of laws within which then the executive branch and private enterprise operate, so any well organized banking institution would be structured within this framework—and this would be equivalent to an investment bank. We had an example with Jesse Jones from the RFC, which was designed for a slightly different purpose, but the same concept. It depends on whether it's well run. Obviously, they're not going to make irresponsible investments if they are properly run. A board of 5, appointed by the President, approved by the Congress, has got to be made up of men and women of outstanding ability and character. They would be audited, so there's no question on that. I just think to say that it's a blank check implies that there's no control or that there would be no judgment or wisdom exercised in the making of the loans. The objectives in the legislation say the loans shall only be made for those projects that contribute to energy independence which cannot receive private capital. Since there's plenty of competitive interest in providing private capital between existing investment houses if the risks warrant the investment. Under the law, as you know, you cannot make an investment if the risks are beyond what seems reasonable or you're subject to suit by the investors.

So that there are limitations which are very sharp, but national interest dictates in my opinion that certain risks be taken which may contribute in a major way to the independence of this country in energy. We have the capacity. It's just a question of finding out what the costs are in various forms of energy production domestically, and I don't think we can overstress the importance of investing the $30 billion we now spend to import oil—$50 to $60 billion later—in the United States for U.S. employment as distinct from sending this money abroad. . . .

B. The Federal Role in Developing New Energy Supplies

SHOULD THE FEDERAL GOVERNMENT ENTER THE OIL BUSINESS?

(By Robert S. Pindyck)*

It is not surprising that Congress has become interested in proposals to push the federal government into the oil and gas business. After the Organization of Petroleum Exporting Countries (OPEC) succeeded in quintupling world oil prices, the big oil companies found themselves more and more in the position of the middleman who purchases crude at a price that he cannot influence and takes a percentage markup on refining and selling. It thus seems reasonable to suppose that a federal company which had the sole right to import crude might have a stronger hand in negotiating prices with producer governments. Also, if that federal company accepted imports only under a system of sealed bids, the OPEC countries might have an incentive to undercut the cartel price in secret. In addition, the exploitation of untapped oil and gas reserves in the United States is now correctly seen as a critical factor in our ability to achieve a greater degree of energy self-sufficiency. Perhaps a federal company that competed with the private companies in exploration for oil and gas could do a better job of discovering new reserves, thereby increasing domestic supplies at lower cost.

There are a variety of proposals to establish a Federal Oil and Gas Company (FOGCO), each of which differs from the others in the extent of government participation recommended. These proposals raise issues involving not only the structure of domestic and world oil markets, but also the relative performance of public and private companies. We shall examine some of these issues in an attempt to evaluate the more representative plans.

PROPOSALS FOR A FEDERAL OIL AND GAS COMPANY

Three proposals stand out as most representative of the growing interest in federal participation in the oil business. The first has been made independently by Senator Frank Church and by the Executive Council of the AFL–CIO. This proposal would limit federal involvement in the energy business to a government monopoly for all oil and gas imports. The argument is that the private oil companies, competing among themselves to purchase crude oil from suppliers that are now sovereign states, have no power to negotiate lower prices. A federal import monopoly, on the other hand, would negotiate very large contracts and therefore be in a better position to obtain a lower price. In addition, by acting as the sole distributor of imported crude, the federal company could guarantee that the big private companies did not restrict the flow of supplies to small distributors, thereby squeezing them out of the market.

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*Reprinted from *Challenge, The Magazine of Economic Affairs* by permission of M. E. Sharpe, Inc., White Plains, New York 10603, May–June 1976, p. 48–51. Robert Pindyck is Associate Professor of Economics, Sloan School of Management, Massachusetts Institute of Technology.

The second proposal, made by Senator Henry Jackson, also recommends that the federal government be the sole importer of crude (both for immediate distribution and for stockpiling), but under a system of sealed bids. The system would require anybody who wishes to sell crude to an American importer to make a sealed bid stating quantity and price. Since bids are secret, there is an opportunity for individual OPEC countries to undercut the cartel price without being found out. In addition, since bidding is competitive, there is an incentive to undercut for fear of losing part of the export market to another country that may submit a lower bid. Senator Jackson would have the federal government, rather than the private companies, act on all bids, thus increasing the stakes for undercutting—or refusing to undercut.

The most extensive proposal has been made by Senator Adlai Stevenson. He envisions a government-owned company that would explore for oil and gas, and exploit up to 20 percent of the Federal oil and gas reserves that the Administration is now trying to lease to private companies for development. This company would also have the sole right to import crude from foreign suppliers, it would ensure the delivery of sufficient supplies to small distributors, and it would even produce its own refined products to be sold to small companies. Senator Stevenson argues that by entering into the search for oil and gas, the federal company would stimulate competition among private firms and speed the exploitation of untapped reserves. The benefits that would arise from the monopoly on imports are similar to those cited by Senator Church in his proposal.

These proposals raise some interesting questions. If a federal company had sole rights to import, would its monopsony power really result in a lower import price? If a federal company imported under a sealed bid system, would this actually encourage price cutting by OPEC members? Would a federal importing company be a truly efficient means of making sure that the large companies did not squeeze the independent distributors out of the market? And finally, can we except a federal company to do a better job of finding oil and gas than the private companies?

WOULD A FEDERAL MONOPOLY ON IMPORTS HELP REDUCE THE PRICE OF OIL?

The Stevenson and Church proposals are based in part on the fact that it is not necessarily in the interest of the private oil companies to bargain hard for low prices on imports. The reason, of course, is that the private companies make much of their profit from the domestic reserves they own, and these reserves increase in value when OPEC raises the price of its oil. A federal importing company (if it did not also own domestic reserves) would not have this conflict of interest, and would bargain for a lower price.

But it is doubtful that the federal company would succeed in obtaining a lower price. Stevenson and Church assume that the federal importing company could exercise effective monopsony power in purchasing crude from producing countries. Unfortunately, for a monopsony to be effective it must be willing to cut back on its purchases if the price is too high. This means that the government must be prepared to precipitate a reduction in imports if the producing countries do not offer "reasonable" terms, that is, it must demonstrate to producers that its impact demand is elastic. It appears, however, that import demand, at least in the short run, is fairly inelastic: neither the Congress nor the Administration seems amenable to accepting sudden reductions in imports (and they should not be—witness the effects of the 1973 embargo).

Even if the U.S. could accept sudden import drops, the effect on OPEC would be limited, since this country accounts for only some 10 percent of total OPEC exports. Thus, unless Japan and the European countries could agree to form a "buyers' cartel" together with the U.S. (which seems highly unlikely), the monopsony power of the federal oil company would be quite small. American threats to cut imports by, say, 2 million barrels per day would simply not succeed in forcing OPEC to reduce its price, particularly in view of the fact that the cartel seems to be able to function quite well now with an excess capacity of around 12 million barrels per day. Furthermore, the major oil companies can purchase bulk orders, many of which are resold outside of the United States. These orders allow more room for price negotiation (and for price undercutting by cartel members) than would orders to a federal importing monopoly.

It therefore does not appear that a federal company would have the economic power to negotiate lower import prices. A federal company could, of course, supplement economic pressure with political pressure in the bargaining process. However, the U.S. government could apply political pressure to the OPEC countries no matter who does the importing. That it has not yet done so is partly due to a desire to maintain its position as mediator between Israel and the Arab countries, a position that could be damaged by excessive political intervention in the world oil market.

Senator Jackson's proposal is perhaps more interesting, for he relies on the sealed bid system to encourage cheating among the OPEC members. The sealed bid system is in fact an excellent idea, and provides at least some promise of weakening the cartel. But the effectiveness of the sealed bid system does not depend on having the government do all of the importing. If anything, a government monopoly on imports would make cheating less likely, since there would be more chance of prices becoming public knowledge, and there would be no opportunity for companies to resell or transfer contracts to each other, thereby confusing the terms of sale.

A more effective scheme was suggested by Professor M. A. Adelman of MIT (*Challenge*, January/February 1976). Under the Adelman plan, import quota tickets would be sold by the government—the Federal Energy Administration (FEA) could do the actual selling—and anyone inside or outside of the United States who was willing to pay cash could bid for them. Each ticket, for example, might give the holder the right to import one barrel of oil. One use of the quota tickets, of course, would be to restrict oil imports by limiting the number issued, but that is not really our concern here; the tickets would also provide a means for OPEC countries to undercut price. The tickets would be freely transferable, and an active resale market would be encouraged. The system would therefore work by permitting OPEC countries to establish "front men" (brokers) who would bid for and purchase quota tickets in the United States.

Suppose, for example, that Libya would like to sell a certain quantity of oil to the United States and was willing to do so at a price $2.00 below the posted OPEC price. Then a broker (representing Libya) would bid for and purchase an appropriate number of tickets at a

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price of $2.00 per ticket. The tickets could then be transferred to an importing company in return for an agreement to buy oil from Libya. This kind of price undercutting would be hard to detect, since Libya would appear to be selling oil at the posted price, but in fact would be giving a $2.00 "rebate" to the U.S. Government in return for an assured sale. Note that this plan depends on having the private oil companies do the importing. If only a federal oil company imported, it would not be possible for OPEC companies to employ brokers to buy and transfer quota tickets.

It should also be noted that some of the OPEC countries would favor a centralization of all sale operations through the Secretariat in Vienna. Centralization of sales is difficult for any international cartel, and would be particularly so for OPEC, since it would create numerous strategic and political problems. If centralization did occur, however, the cartel would be strengthened considerably, and none of the schemes mentioned above would be effective in weakening it.

As we have seen, a federal monopoly on oil imports is not likely to achieve a reduction in the price of oil. But would such a monopoly at least serve to protect the small independent oil companies? It could be designed to do so, but would require a distribution scheme so elaborate, not to say inefficient and certainly costly, as to be a significant drawback for any federal oil company. An easier way to protect the independents would be to give them the right to purchase specified quantities of oil from the larger companies at a set of average prices. Under the current system, private companies can contract for imports to meet their planned future needs.

WOULD A FEDERAL COMPANY DO A BETTER JOB OF FINDING OIL?

Would a government-owned company be more efficient than private entrepreneurs in finding new oil and gas reserves? Here we must also ask: Might the differences in objectives (profit maximization vs., perhaps, revenue maximization subject to a breakeven on profit), or the differences in operating constraints (maximum debt levels vs., perhaps, floors on losses and risk) affect relative exploration performance? And would such differences tend to shift exploration toward inefficient risk-averse projects? Again, as to the allocation of capital, would it be shifted more toward supporting exploration or toward such activities as refining and marketing?

Unfortunately we have no quantitative answers to these questions. The "conventional wisdom" has it that private oil companies generally do better in exploration than public bodies, which are too risk-averse. True, executives of public companies would have to defend their decisions before governmental authorities—but oil exploration sometimes has to be based on contradictory sets of geological evidence, and, notoriously, often results in a series of failures. Nevertheless, it is the high-risk areas that often bring in a high return.

Can we fairly compare private-vs.-public discovery rates per dollar of expenditure? Critics of public oil companies often ignore geological differences that affect costs in one location as compared to another. They also make examples of the smaller public companies that do not enjoy economies of scale. A recent FEA report comparing financial statistics for six private and six public companies pointed out that the average net income as a percentage of equity was higher for the private companies, as were average output in barrels per day per employee, and average yearly sales per employee.

But these statistics are misleading because public companies often do not seek to maximize profit. For example, Mexico's PEMEX has been selling oil to Mexicans at $8.00 per barrel, not at the $12.00 per barrel it might get if it were interested in maximizing its net income. Similarly, Colombia's ECOPETROL, until recently, sold oil locally at about $2.00 per barrel. Private companies can also reap larger profits from refining and marketing; has any financial comparison looked *only* at the exploration side of company activities?

All in all, there is really little evidence to support the notion that public oil companies do not perform as well in exploration as private ones. In fact, there is evidence to support the argument that they do at least as well, and Senator Stevenson was right in rejecting the conventional view when he proposed a federal gas and oil company.

Examine the table, for example, which compares drilling success ratios for public and private companies exploring in the same country. (Geological conditions can vary considerably from nation to nation, so that it is not meaningful to compare drilling results as between countries.) Observe that, except for the Indonesian activities of JAPEX and AGIP, the public companies generally have higher drilling success ratios than any of the private companies operating within the same country.

Obviously we cannot conclude from the fragmentary evidence in the table that public oil companies are more efficient in finding oil. The numbers do not take into account, for example, the *size* of discoveries; it may be that some of the private companies have had lower success ratios because they have been drilling in higher risk regions where the probability of success is low but the expected size of discovery is larger.

A proper comparison must consider not only success ratios, but also the distribution of sizes of finds. In addition, there may be governmental restrictions on which companies can drill where, and local state-owned enterprises may be favored. Clearly, we need much more reliable data on the past performance of public and private oil companies in exploration and development, data describing the relative risk-return characteristics of drilling "portfolios" of public and private companies, as well as data comparing drilling costs and discovery sizes for wells drilled in areas with comparable geological conditions.

Any evaluation of the desirability of a public oil company in the United States must emphasize the probably response for such a company to risk in exploratory activity. Excluding Alaska, most of the new oil reserves to be found in the United States during the next twenty years will come mainly from offshore drilling and secondarily from drilling in the few remaining unexplored onshore areas. Even in the past decade, a few large discoveries have accounted for most of our new reserves. The issue, then, is whether a federal oil company can outperform the private companies in high-risk ventures. Unfortunately, this question cannot be answered on the basis of our current limited knowledge.

DO WE NEED FEDERAL OIL COMPANY?

It does not appear desirable at this point to establish a federal oil company for purposes of importing crude. The problems of distribution will be considerable, and there is no reason to expect that the federal importer will be able to weaken OPEC or otherwise obtain a price reduction. On the other hand, it may indeed be desirable at some point to establish a federal oil and gas company that explores for and develops new reserves. Perhaps the best way to find out whether a public company can do a better job of finding oil and gas in high-risk areas than private companies can may be to establish a FOGCO and watch it perform.

While in the long run a FOGCO might help increase our domestic oil and gas supplies, we cannot look to it now as a basis for our energy policy. It is true that we have not developed new domestic energy sources as rapidly as we had hoped. Indeed, oil and gas discoveries are low, and if present trends continue, we can expect an increased dependence on imported energy supplies. But this may be due in part to an inefficient pricing system that discourages both exploration and production, as well as an offshore leasing system which, by emphasizing up-front payments for exploration rights, increase risk, thus maintaining the dominance of the larger companies and discouraging competition. These problems can be solved, and solving them would help provide more domestic oil. But we also face growing uncertainty about the quantities of oil and gas that exist underground. Because of this we should accept the fact that unless we are willing to pay extremely high prices for energy, the U.S. will continue to import oil—at world market prices.

EXPLORATORY WELL DRILLING, 1968-1973 (6)-yr totals)

Country and company	Total exploratory wells drilled	Successful wells	Success ratio
Colombia:			
ECOPETROL[1]	8	3	0.375
Tenneco	18	6	.333
Shell	5	0	0
British Petroleum	1	0	0
Texaco	11	3	.273
Peru:			
PETROPERU[1]	77	35	.454
Tenneco	6	2	.333
Occidental	9	4	.444
Amoco	8	4	.500
France:			
AGIP[1]	15	10	.667
JAPEX[1]	7	4	.571
Shell-B.P	114	50	.439
Tenneco	3	0	0
Gulf	19	10	.526
Mobil	35	15	.429
Texaco	11	4	.364
Occidental	6	2	.333
Nigeria:			
ERAP[1]	17	8	.471
SNAP[1]	32	3	.094
Shell	11	2	.182
Indonesia:			
PERTAMINA[1]	38	14	.368
JAPEX[1]	17	0	0
AGIP[1]	17	1	.059
Mobil	20	4	.200
Gulf	15	0	0
Shell	6	0	0
Tenneco	15	4	.267
Libya:[2]			
AGIP[1]	17	2	.118
SNPA[1]	17	6	.353
British Petroleum	14	2	.143
Occidental	27	3	.111
Mobil	56	8	.143
Shell	8	0	0
B.P.-Hunt	16	4	.250
Amoco	7	2	.286

[1] Public companies. AGIP is a subsidiary of Italy's ENI; ERAP are SNPA and French owned; JAPEX is partly owned by the Japanese government; and ECOPETROL, PETROPERU, and PERTAMINA are respectively Colombian, Peruvian and Indonesian national oil companies.

[2] Includes only new field wildcat wells.

Sources of data: AAPG Bulletin, International Oil Scouts Association Yearbook.

TESTIMONY OF INDEPENDENT PETROLEUM ASSOCIATION OF AMERICA (IPAA)

[From Hearings before the Subcommittee on Energy and Foundations of the Senate Committee on Finance on "Incentives for Developing New Energy Sources," p. 170–188. Hearings held June 20 and 21, 1977.]*

The purpose of our presentation is to suggest critical changes which must be made in the Administration's approach [the National Energy Plan] to energy development if domestic producers are to have an opportunity to meet future needs of consumers for petroleum fuels. The administration is pressing for total Federal authority to fix the prices and "manage" the supplies of oil and gas on a basis which, in our view, would assure declining production and chronic shortages.

Because the United States already has a very large and growing deficit in its domestic supplies of both crude oil and natural gas, it is our firm conviction that adoption of the administration proposals would so aggravate our future supply position as to cause intolerable impacts on our balance of payments and unacceptable security problems arising out of our loss of control over critical supplies of energy.

The proposals suggested, Mr. Chairman, would amount to a regulatory overkill that would so limit domestic exploration-development investment that dependence on insecure foreign energy would be extended to levels which may never be corrected. When this occurs, many will say, "The industry has failed the consumer. The Government must now take over." Should that happen, our country will—in my opinion—be on a headlong course into an energy doomsday that is unnecessary and therefore avoidable.

Let's look for a moment at where we stand today. In January this year for the first time petroleum consumption exceeded 20 million barrels per day. Imports of petroleum exceeded domestic production—that is, we are approaching 50 percent dependency whereas as recently as 9 years ago we had the ability to produce more oil and natural gas than we consumed. Our January balance of trade reflected the worst deficit in the history of the United States with imported oil accounting for a major share. In 1976 the total cost of imported oil and natural gas was $37 billion. By comparison, the total wellhead value of all domestic oil and gas—which provided 2½ times the energy equivalency—was about $36 billion.

There appears to be no disagreement about the need for incentives to develop alternatives to conventional oil and natural gas supplies. What does seem to be overlooked by both Congress and the administration is the need to bridge the gap from now until that day when we can rely extensively on alternatives. Crude oil and natural gas presently supply some 75 percent of our energy. For the next several years, we will become increasingly more dependent on insecure foreign oil unless we have a vigorous, healthy and expanding domestic petroleum industry. Instead of being encouraged by sound, consistent policies, oil and gas producers have been confronted with the following:

(1) October 9, 1969—percentage depletion cut from 27½ percent to 22 percent;

(2) March 29, 1975—enactment by Congress of Tax Reduction Act of 1975, substantially repealing percentage depletion for about 85 percent of domestic oil and gas. This long-standing tax policy has been left intact for some 100 other extractive industries;

(3) February 1, 1976—rollback of approximately $1.50 per barrel for new crude oil;

(4) September 16, 1976—enactment by Congress of Tax Reform Act of 1976, retroactively imposing punitive tax on expenditures, not on income of independent oil and gas producers;

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*Testimony of A. V. Jones, Jr., President, Independent Petroleum Producers of America.

(5) July 1, 1976—imposition of a price freeze on all domestic crude oil;

(6) December 31, 1976—a rollback of 20 cents per barrel for new domestic crude oil and continuation of existing price freeze on crude oil;

(7) February 1, 1977—a retroactive doubling of rental fees on most oil and gas leases on Federal onshore lands;

(8) March 1, 1977—a rollback in U.S. crude oil prices of 45 cents per barrel on new oil.

The continued impact of these actions on domestic oil and gas producers is to remove roughly $5 billion annually which otherwise would be available for additional exploration and drilling. This listing should dispel any doubt as to why our domestic oil and gas production is declining and why we grow ever more dependent on insecure foreign oil. The 10,000 independent producers and explorers who drill most of the wells should be making a maximum effort in developing new supplies. But they are not because of the counterproductive effect of adverse Government policy. During 1975 and 1976, active rotary rigs were at a standstill, averaging about 1,650 rigs. Twenty years ago there were over 2,600 rigs active. We should be utilizing 4,000 rigs if we are to bring on new production adequate to reverse our intolerable dependence on foreign supplies. This will require positive actions by Congress and the administration.

Under long years of price regimentation and punitive tax actions, total drilling in the United States declined by 51 percent on an uninterrupted downtrend from 1957 to 1972. Retrenchment by independent producers was the sole factor in the curtailment of domestic exploration and development. Expenditures by the large companies, the so-called "Chase Bank Group," actually increased during this period.

Under pressure of a progressive cost-price squeeze imposed by rigid wellhead price controls, about half of the independent explorer-producers active in the mid-1950's had merged out, sold out or simply gone broke by 1971. Some 10,000 former independents left the industry during this period. The industry was decimated for one primary reason: unrealistic and anticompetitive price-fixing by the Federal Government.

While domestic oil and natural gas exploration, development and production is the most highly competitive major industry in America, there has been a trend toward concentration since the mid-1950's. This trend was caused directly by Federal Government intervention to fix wellhead prices, which established an economic climate in which marginal producers could not survive. Under Government-administered pricing, the large units with profit centers worldwide survived better.

When Government determination and dominance of economic conditions are carried to the extreme, only the big can survive. The Carter administration energy program is a blueprint for such dominance.

From 1956 to 1972, geophysical activity, which has been a reliable barometer indicating future directions of rig and drilling activity, dropped 60 percent. Active rotary rigs declined 58 percent, and both exploration and total well completions dropped well over 50 percent.

While these basic activities directed at finding and developing oil and gas supplies were declining over these many years, the demand for oil increased 86 percent and consumption of natural gas rose 120 percent. The result was declining reserves, resulting in inevitable and progressive domestic shortages and rising dependence on foreign energy supplies.

This whole experience demonstrated the vitally important role of the thousands of independent producers. Even though the total number of independent explorer-producers dropped by half from the mid-1950's up to the time of the 1973 embargo, in the latest 5 years of this period, 1969–73, independents as a group continued to dominate in domestic petroleum exploration and development.

In the 1969–73 period, independents drilled 89 percent of domestic wildcat wells, found 75 percent of the significant new oil and gas fields and accounted for 54 percent of the oil and gas reserves found. This is a significant contribution toward the total effort to provide increased domestic petroleum supplies. The problem has been that the industry as a whole, and independents in particular, have performed at a declining and inadequate level for most of the past two decades.

Beginning in 1974, after a 17-year cost-price squeeze that progressively thinned the ranks of independent explorer-producers, the domestic industry set in motion a resurgence of effort which promises to add significantly to domestic oil and gas supplies. The industry's responsiveness in this short period has demonstrated conclusively what producers have been saying for years—that expenditures to find and develop petroleum fuels would increase in direct proportion to improved price incentives, as they always have.

While the increased drilling response since the 1973 embargo has been significant, it is barely a start toward doing what can and should be done to increase domestic gas and oil production in the next two decades until alternative energy resources can be brought on stream.

The primary stimulus for increased natural gas exploration and development has been increased incentives of market pricing for intrastate natural gas. It is significant that where difficult intrastate shortages of gas existed in 1974–75, in Texas and some areas of Oklahoma and Louisiana, the market has now cleared and contract prices are generally down by approximately 50 cents per thousand cubic feet from the peak prices of a year or so ago.

Instead of building on this positive experience, the Administration has adopted a defeatist, no win approach which reflects a lack of faith in the proven ingenuity of our industry in finding and providing increased gas supplies, and an unjustified faith in a regulatory system that has been a failure on every count. It is disturbing that this approach is apparently grounded on a number of premises that are without support in our prior experience.

I would like now to discuss specifically some of the administration's premises which, taken together, reflect an unjustified lack of faith in our proven capacity to solve problems.

The primary and overriding premise of the Carter program is the conclusion that our petroleum resource base is not sufficient to permit significant additions to supplies. In the case of natural gas, this conclusion was expressed by Mr. John F. O'Leary, the administrator of FEA, who said that natural gas "has had it." Such a conclusion is not justified by anything in the great body of both private and Government data that reflect expert evaluations of the remaining geologic potential for both gas and crude oil.

Professional geologists nationwide agree that vast quantities of natural gas remain to be produced in this country. In 1967, the National Petroleum Council, at the request of the Department of Interior, began a study of future petroleum provinces of the United States. The results of the coordinated study, in which dozens of the nation's most prominent geologists participated, was published in two volumes in 1971. Over 3,000,000 square miles of basinal area in the United States were identified as having sediments prospective for oil and gas. This compares with only 50,000 square miles on which oil and gas production exists, or has existed to date—less than 2 percent of the prospective area, and most of that is relatively shallow. With the nation being called on to attack energy shortages with the "moral equivalent of war," it seems highly inconsistent that we should also be told to turn our backs on 98 percent of the prospective oil and gas sediments, and simply lie down under a flag of surrender. Americans have not responded to the great challenges of the past in this manner.

The U.S. Geological Survey study of 1975 is within the range of estimates of most resource base studies and is considered realistic by many. The U.S.G.S. estimates for potential conventional natural gas and oil resources are shown in the chart "U.S. Petroleum Resource Base." The proved and potential gas supplies in this evaluation amount to a 55-year supply at the 1976 production rate. Another 10 years' potential exists in "currently subeconomic" resources that U.S.G.S. believes will become available with improved technology and/or economics.

These estimates do not include potential natural gas volumes from tight shales and sands in both the Western and Eastern United States, geopressurized reservoirs on the Texas-Louisiana Gulf Coast, or in sediments below water depths of 600 feet. Attached to my statement is a summary from a draft ERDA study which estimates a total gas potential of 730 trillion cubic feet in just four tight sand basins in the Rocky Mountain area. Obviously, development of techniques which would bring these tremendous potentials into production would extend our access to natural gas not by just decades, but by more than a century.

Just as obviously, an economic climate under price regulation that would inhibit development of conventional oil and gas, which the Carter plan assuredly would, also would postpone development of these high-technology resources for the indefinite future. It would be selling the country's consumers tragically short to write off the possibility of improving future supply when we have identified potential supplies in such great abundance.

Another faulty premise upon which the Administration is basing its scheme for permanent price controls is its argument that, "Higher costs (prices to producers) do not yield more oil and gas." All past experience refutes that contention. More oil and gas always has been provided by drilling more wells. Levels of drilling always have been determined by prices at the well for oil and gas, as illustrated by the chart "U.S. Oil and Gas Prices vs. Drilling Expenditures." For each change (up or down) of 10 cents per barrel in the composite oil and gas price, there has been a corresponding change of $120 million in drilling expenditures.

Since 1973, the rise of approximately $2.36 per barrel in this composite price has stimulated increases in expenditures of $3 billion per year. Claims have been and are being made to the effect that this acceleration in drilling is not adding to supply. These statements reflect an expectation that an industry which declined for 17 consecutive years and was in an atrophied condition just four years ago should be able to achieve a turnaround in declining production in just three years. Such expectations are totally unrealistic. On the other hand, they ignore the progress which has been made. Production in 1976 was 2.5 trillion cubic feet more than it would have been had drilling continued to follow the 1960-71 trend. Except for this real gain in natural gas production as a result of increased drilling in the past four years, oil import dependence in 1976 would have been more than 1,250,000 barrels daily higher and our dollar outflow for foreign oil $6.1 billion greater.

Similarly, our data shows that the decline in domestic crude oil production has been substantially arrested and production is some 800,000 barrels daily higher than would have been without the 1973-77 acceleration in drilling.

Last year Congress decontrolled wellhead prices of stripper well crude oil. As an indication of producer response to incentives, I note the following results. Abandonments of producing stripper wells have declined sharply . . . 44 percent in the three states which contain about one-half of all the stripper wells in the country—Texas, Louisiana, and Kansas. Total producing wells in the United States increased from 497,000 to 503,000 during 1976. This resulted from increased drilling as well as the decline in abandonment of stripper wells due to the removal of price controls and resultant increase in the economic life of many wells.

Equally important is that stripper well production now accounts for approximately 16 percent of domestic oil production—up from 13 percent a year earlier—and stripper reserves are now estimated at 7.5 billion barrels—up from 5.8 billion in 1973. These results are a response to the positive incentives of increased prices.

We have made only a small start in mobilizing the exploration-drilling arm of the domestic industry to the level of activity at which it can and should be operating. To make the oil and gas supply contribution necessary to see the nation through the transition period of the next two decades, we must effectively double the present rate of drilling. This brings me to still another unsupportable premise of the Carter energy policy staff which in one memorandum states that reduced energy growth is "fully compatible with economic growth development of new industries, and the creation of new jobs." Contrary to the facts, they state flatly, "there is no fixed relationship between energy and GNP."

But over the last 20 years, energy consumption, GNP and employment have been mirror images of each other. In fact, energy consumption equivalent to one billion barrels of oil consistently has been accompanied by $100 billion in GNP and the addition of 4 million new jobs.

What of the future? The Department of Labor's projects that our economy must accommodate 104 million working Americans by 1985. This work force would generate a 1985 GNP of $1,850 billion in 1972 dollars. Based on past experience, this expansion in economic growth will require an increase in energy use of about 50 percent.

In 1975, we consumed approximately 12 billion barrels of oil equivalent. The Chase Manhattan Bank estimates that the petroleum industry must spend some 265 billion (current) dollars in the decade 1975 to 1985 on domestic exploration and development in order to accomplish levels of energy adequate to support our workforce in 1985. With 1976 and 1977 almost behind us, the industry will have to expend at the rate of almost $25 billion per year on the average from 1978 until 1985 in order to achieve the lower level of energy supply of 15 billion barrels of oil equivalent targeted by the President's energy plan. The President's Crude Oil Pricing Policy, Natural Gas Pricing Policy and Petroleum Taxation Policy are inadequate to generate these substantial sums of necessary capital.

Unlike most other industries, the petroleum exploration industry is a high risk industry which requires investor capital in hand. Money cannot be borrowed to carry out exploratory drilling programs. The President's National Energy Plan (NEP) falls short in that it fails to acknowledge that the price of a commodity must not only provide the incentive to invest capital to bring on new supplies and also must provide the cash flow from existing production to generate the investment capital. Even if the President's definition of "new" crude oil were reasonable and provided market level incentives for significant numbers of potential investments, producers would suffer cash flow restrictions under the President's program that would disallow maximum effort to increase domestic supply.

The National Energy Plan would price crude oil on a replacement cost basis, but the Crude Oil Equalization Tax (COET) would tax all the increased cash flow from the producer. The COET amounts to a massive income redistribution plan. None of the tax would accrue to the producer for the purpose of increasing crude oil supplies. In the face of naturally declining existing production and an inadequate inflation adjustment factor to fully reflect increasing oilfield costs, the producer would be unable to generate sufficient capital to replenish the reserves he produces.

Natural Gas Pricing Policy as proposed in the NEP suffers the same basic economic failings. It would extend federal control of the price of natural gas sold in the interstate market, a concept which has failed miserably, to the intrastate market. The proposal would in fact, roll back process of some intrastate gas. Consumers of America will have less natural gas available under the President's Natural Gas Pricing Proposal than would be available under the present situation.

Although the President recognized the adverse nature of including intangible drilling expenses as a tax preference item subject to minimum tax, the National Energy Plan failed to recognize other critical limitations on capital formation for independent producers. The provision which limits allowable depletion to 65 percent of taxable income and the recent IRS Revenue Ruling 77–176 particularly inhibit independent oil and gas producers from generating internal funds and raising capital from outside investors. . . .

In summary, in order to accomplish the stated objectives of the President's program or the Chase Manhattan Bank's estimates, a favorable economic environment for investment in the domestic petroleum industry must be provided.

Finally, the faulty premises of the NEP include a highly pessimistic appraisal of the ability of the support industries supplying rigs, pipe and other materials to provide the hardware to significantly expand exploration and development. Again, the experience of our industry should allay any concern that we would be inhibited by rig shortages or other shortages—except where government policy may signal such uncertainty about the economic climate that fabrication of needed equipment is frustrated.

Almost 800 units have been added to our operable rig inventory since the preembargo year of 1972. I might say this is 200 rigs more than expert analyses within the industry itself had indicated. Again, there is no basis for selling short our ingenuity and ability to get on with the task of developing critically needed energy resources.

SUMMARY

IPAA firmly believes that the solution to our intolerable dependence on foreign crude oil is to unleash private enterprise by relying on market forces to efficiently allocate existing energy supplies, stimulate innovations to conserve our natural resources, and maximize efforts to increase domestic supplies to balance demand with supply. The United States has the potential petroleum resources; and with the proper economic environment, the support industries have the capability of responding to increased demand for their drilling rigs, pipe and equipment.

We must recognize that conservation alone cannot solve our energy problems. To rely on conservation is to risk a highly regimented economy with staggering unemployment and unprecedented invasion of individual freedom of choice which is a cornerstone of the American system.

In the long term alternative sources of energy will be able to assume a greater share of our energy burden. However, in the shorter term of the next decade or so, crude oil and natural gas will continue to provide the bulk of our energy requirement. The only real question remaining is whether crude oil and natural gas will be developed from our domestic resource base or whether we will allow ourselves to become increasingly dependent on foreign nations for our energy lifeblood. The attendant balance of payment problems and the precarious national security situation make it clear that U.S. consumers should rely on U.S. producers, not foreign countries, for their energy supplies.

RECOMMENDATIONS

Recognizing that replacement cost of energy in the United States is the cost of imported energy and that it is economically efficient and prudent to encourage domestic crude oil and natural gas production at market prices up to that cost to maximize domestic production, stimulate conservation and conversion to alternative fuels, and reduce energy imports, we urge adoption of:

A. Crude oil pricing policy

1. Decontrol the price of upper tier crude oil and all economically marginal crude oil. This will maximize incentives to increase production and prevent the premature abandonment or shutting in of domestic production which would otherwise have to be replaced by foreign imports.
2. Phase out price controls on lower tier crude oil by the end of May, 1979. This would provide the capital necessary for exploration and development to increase the supply of energy for consumers. This would also eliminate the need for a cumbersome entitlements program and other regulatory burdens. Consumers would be given a clear signal that future prices of energy will reflect replacement costs.

B. Natural gas pricing policy

Encourage increased natural gas production by deregulating the price of new natural gas and phasing out controls on old gas. IPAA specifically supports H.R. 2088, introduced by Congressman Krueger, et al., and S. 256, introduced by Senators Pearson and Bentsen.

C. Petroleum taxation policy

The Congress must provide a sound, reliable oil and gas taxation policy which encourages capital formation and spending in the domestic oil and gas producing industry. The Congress must also correct past taxation policies which are now inhibiting investments in drilling crude oil and natural gas exploratory and development wells. Specifically, Congress should:

1. Eliminate for independent producers intangible drilling expenses as a tax preference item subject to the minimum tax. Such a tax is not a tax on income, but instead is a tax on expenditures.
2. Repeal the 65 percent of taxable income limitations on allowed depletion for independent producers of crude oil and natural gas. This provision discourages independent producers from maximizing their drilling investments.
3. Prevent further deterioration in the percentage depletion rate and allowable volume. This would alleviate further deterioration of the capital base of independent producers.
4. Provide for expensing of geological and geophysical expenses rather than requiring their capitalization.
5. Enact an Energy Development Investment Tax Credit which would allow a direct credit against federal income tax for expenditures intended to result in greater domestic energy supplies.

D. Accelerate leasing program

Accelerate the leasing of federal lands on the Outer Continental Shelf for oil and gas exploration and production and reverse federal public lands policies which result in the withdrawal of significant areas from mineral exploration and development.

E. Conservation

Stimulate conservation of energy and our national resources not through artificial taxes, end use controls, or rationing, but by pricing energy according to the competition. This is the most efficient and least disruptive way to achieve desired results.

F. Regulatory reform

Eliminate counterproductive regulations and streamline procedures for the siting of energy facilities and transportation systems.

We have the natural resources, knowledge and capacity to solve our energy problem. What we lack are adequate incentives which the market place will provide if unreasonable government interference is removed.

C. The Relationship Between Federal and State Government in Energy Policy Planning

ENERGY POLICY: A TEST FOR FEDERALISM

(By Jon Mills and R.D. Woodson)*

The central problem of federalism results from the lack of a clear demarcation of authority between the states and the federal government. The extent of state power has been a point of contention from the writing of the federalist papers to the cry of states' rights during the school desegregation controversy. In recent years the dispute has focused on clashes between state and federal energy policy. State and federal perspectives regarding energy may differ markedly. To the federal government the energy issue involves balance of payments, foreign relations, and national security. To state and local governments, on the other hand, the focus is pragmatic and localized, the welfare of the state and its citizens being the primary concern. Thus, for instance, concern for safety may make a locality leery of nuclear power, while the federal government sees it as the only alternative to drastic increases in oil imports.

Three possible allocations of governmental responsibility are possible. In certain areas of exclusive federal responsibility, the preemption doctrine precludes any role for the states. Traditional examples of preemptive activity are found in the federal government's leasing of oil bearing lands on the Outer Continental Shelf [OCS] beyond the 3-mile limit and the Federal Power Commission's [FPC] control over pricing of natural gas intended for the interstate market. In other areas, where the federal government has failed to act expressly or impliedly or where the Constitution has been interpreted as failing to delegate authority to the federal government, the state may act under the police power to protect its citizenry from potential adverse impacts of energy development and utilization. These principles are consistent with traditional notions of federalism, whereby the state and federal governments are viewed as pitted against one another for authority or jurisdiction, with the judiciary as the final arbiter.

The third possibility reflects a more modern view of federalism which embraces the concept of state-federal cooperation. Cooperative efforts, in addition to avoiding divisive power struggles, can utilize the strengths of each level of government: a federal mandate may give added force to an enactment and counteract certain local pressures on state governments, while state involvement will increase sensitivity to local problems and conditions and contribute to effective ultimate implementation. Perhaps the most significant advantage is the ability of the combined federal-state authorities to draw on all the power allocated to government in the American constitutional system. The increasingly complex nature of energy problems and solutions seems to favor the cooperative approach of this new federalism, under which a solution tailored to the diverse energy needs of America's varying geographical and sociological conditions is more readily achievable.

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*From the Arizona Law Review, Vol. 18, no. 2, 1976, p. 405–451. Copyright © 1977 by the Arizona Board of Regents. Footnotes have been omitted in the interest of brevity. At the time the article was published, Jon Mills was Executive Director of the Center of Governmental Responsibility, University of Florida, and R. D. Woodson was Assistant Director. Reprinted by permission.

Under neither the traditional nor the new federalism can the numerous facets of the energy problem be resolved in a single effort. Energy policy development affects numerous topics critical to the states, ranging from land use to air and water pollution to public transportation. It thus is not a unified issue, but a conglomerate of otherwise tangentially related matters linked only because all involve energy. The consequence of this diversity is that policy formulation appears as either a shotgun effort to treat all aspects without adequate depth in any, or as an overly narrow policy that fails to treat comprehensively the ramifications of the whole energy question. Because energy is elemental to an industralized society, the implications of energy policy change as suddenly as the society and its technology. Therefore, no evaluation of energy policy or energy conservation can hope to solve completely the energy problem. Similarly, the variable nature of energy problems and policies precludes a final demarcation of the boundaries of state and federal authority in this area. However, certain limits and desirable patterns can be defined to guide legislators at the state and federal levels in determining appropriate areas for exercise of their authority.

This Article will examine the bases of state and federal power, exploring areas of both potential and existing conflict within the energy field. Situations in which either the state or federal government appears to have exclusive authority also will be scrutinized. Possible answers to problems caused by the clashing of governmental interests will be suggested, with an eye toward aiding policymakers to reach agreements which may avert such conflicts. Finally, a prognosis of the future of federalism in regard to the energy issue will be offered.

SOURCES OF GOVERNMENTAL POWER

It is fundamental constitutional doctrine that the United States government is one solely of delegated powers. Those powers not expressly granted to the federal government in the Constitution are reserved to the states. It is from this basis that an examination of the respective powers of each level of government must proceed.

Powers Delegated to the Federal Government

Any analysis of state and federal authority to make energy policy should begin with the supremacy clause since it is the Constitution's most direct statement on the state-federal power relationship. This clause gives preemptive power to federal enactments supported by constitutionally enumerated federal powers, thus enabling them to override conflicting state laws. Preemption can become operative through an express congressional statement to that effect, or it can be implied from the circumstances. For instance, implied preemption may be found where a state regulation produces results inconsistent with the purpose and goals of a federal statute, where federal regulation is so pervasive as to preclude state authority, or where the particular subject regulated demands uniformity among all states.

Caution must be exercised in concluding that a matter is one giving rise to implied preemption. Even though a matter may be one amenable to nationwide regulation, Congress may allow the states a role in an area where federal preemption might be otherwise assumed. An example is provided by the case of *Askew v. American Waterways Operators, Inc.*, ruling on the constitutionality of Florida's Oil-Spill Prevention and Pollution Control Act. The contested state legislation, which imposed strict liability for damage resulting from an oil spill in Florida's territorial waters, was alleged to be preempted by the Water Quality Improvement Act of 1970 and overriding principles of federal maritime law. Despite the pervasiveness of federal controls under the Water Quality Improvement Act and the federal government's historical domination of maritime law, however, the Supreme Court upheld the state legislation, pointing to specific congressional expressions of an intent to maintain a role for the state in regulating oil pollution. The Court declared that "sea-to-shore pollution" was "historically within reach of the police power of the states," and that the federal and state enactments were "harmonious parts of an integrated whole." This decision clearly demonstrates that, despite the possibility of preemption, federal statutes may set standards relating to energy and at the same time allow or encourage state standards which may be more stringent.

Most disputes over application of the supremacy clause involve neither a manifest congressional approval, such as that present in the *Askew* case, nor a clear expression of preemption. The Supreme Court itself has recognized that each case is decided on its own pecularities and that "prior cases on preemption are not precise guidelines" to be followed. Because the issue is subject to such wide-ranging judicial discretion, a court's evaluation of the subject matter as national or local can be conclusive. The existing cases establish that, as a general rule, preemption of a traditional state power is not favored, therefore, when preemption or lack thereof is not clear on the face of the statute, the nature of the power exercised by the state apparently will influence the determination. From these general trends, however, no long term guidelines can be formulated. Conceivably, a local matter of today will be a matter requiring nationwide uniformity in the future, or vice versa. Preemption doctrine thus can be clarified little further than a delineation of the three somewhat broad qustions that must enter into any preemption determination. First, is the basic claim of federal authority constitutionally exercised? Additionally, did Congress express an intent as to whether preemption should operate? Finally, if congressional intent is not manifest, does the subject matter require preemption or is it a local matter? In energy matters, the answer to the first of these questions generally depends on interpretation of the constitutional delegations to the federal government of the power to tax and spend and the power over interstate commerce. Occasionally, the war power also may have relevance.

The Spending and Taxing Powers.—The federal spending power, which originates in article I of the Constitution, authorizes Congress to appropriate and spend in promotion of any objectives deemed worthwhile in furtherance of the general welfare and subject to the limitations of the Bill of Rights. The spending power is often used as a public policy tool, to provide incentives for citizens and local governments to take actions not ordinarily within federal control. With this type of federal action, therefore, development of state energy policies can be subjected to a broadened federal influence.

"Buying compliance," as in the Emergency Highway Energy Conservation Act, is the most significant such exercise of the spending power. Conditions imposed on grants, contracts, and other expenditures by the federal government ensure state cooperation with stipulations which Congress could not otherwise constitutionally impose. Courts recognize no legal restrictions on such conditions so long as there is no abridgement of due process. The states, of course, are free to ignore federal policy thus imposed simply by rejecting conditional grants; once money has been accepted on conditions, however, the conditions must be satisfied.

Congress' authority to lay and collect taxes also is subject to few limitations. Although the basic purpose of this power is production of revenue, other objectives such as the conservation of energy may be accomplished through tax incentives. Taxes have been used to affect energy policy, for example, with the oil depletion allowance. Tax incentives relating to energy conservation, such as increased gasoline taxes, have been continually proposed.

The Commerce Power.—As initially interpreted, the distribution of federal and state powers effectuated by the commerce clause embodied the concept of dual sovereignty, in which the states and the nation exercised exclusive authority in their respective spheres. Thus a dichotomy existed between interstate and intrastate commerce which was also the dividing line for government authority. With the growth of industry and commerce to national dimensions and the advent of social and economic focus transcending local concern, the artificial interstate-intrastate dichotomy animating the concept proved to be untenable. The resultant break with traditional doctrine was achieved through the Supreme Court's expensive redefinition of the federal interstate commerce power to include matters formerly considered intrastate in nature. Such power, however, is not limitless. In determining the validity of a congressional exercise of commerce clause power to regulate purely intrastate activity, the determinative question is whether Congress has a rational basis for finding that the regulated activity affects interstate commerce. If it does, the means selected by Congress to eliminate the evil must be reasonable and appropriate. Congressional power may not be extended so as to encompass effects upon interstate commerce so indirect and remote as to obliterate the distinction between what is national and what is local. The Supreme Court, in establishing these principles, has recognized the need to reserve some matters of commerce regulation to the state and to place some restrictions on congressional power.

Nevertheless, the expansion of federal interstate commerce authority has resulted in increasing judicial scrutiny of state regulation of commerce. The Supreme Court has recognized that despite Congress' power over interstate commerce, the states are not precluded from exercising their police powers in matters of local concern, even if such an exercise affects interstate commerce. However, substantial limitations remain on state regulaton of interstate commerce. A major restraint, and one relevant in establishing energy policy, is the prohibition against a state's attempting to isolate itself from problems shared nationally. Additionally, any attempt at state regulation must be reasonable and necessary in light of local interests and concerns. In *Cities Service Gas Co.* v. *Peerless Oil & Gas Co.*, for example, the Supreme Court held that state regulation must protect a manifest local interest and must outweigh any national interest in equivalent regulation. Upheld in that case was the power of a state to set natural gas prices at the wellhead as a means of preventing uneconomic dissipation. The state and federal interests in conservation coincided and the state means adopted were held reasonably related to this legitimate end. This case illustrates that where regulation of local matters also operates as a regulation of interstate commerce, reconciliation of conflicting claims of state and national power may be attained only by appraisal and accommodation of the competing demands of the state and national interests involved. Where the balancing of interests indicate a considerable state interest in the regulation, impingement upon the underlying federal commerce power may be allowed.

War Powers.—Under the war powers clause of the Constitution, the federal government has exclusive control over matters affecting national security. Where federal authority is based on war powers, preemptive effect is uniformly recognized. In relation to energy, three areas of war power authority have been recognized: control of oil policy, generation of electric power, and atomic energy.

Recognition of the relationship between oil policy and national security began in 1904 when President Taft withdrew several million acres of public lands as naval oil reserves to ensure the Navy's ability to fulfill its fuel requirements. Furthermore, as early as 1954 the need to supplement domestic supply with imported oil was thought to present a threat to national security. In partial response to this perceived threat the Trade Agreements Extension Act of 1955 was passed, requiring the Director of the Office of Defense Mobilization to advise the President whenever there was reason to believe that any article was being imported in such quantities as to threaten national security. Pursuant to this Act, the Mandatory Oil Import Program was established in 1959, giving the President authority to regulate quota levels and allocations to domestic claimants. This function has been handled by various agencies in the executive branch, and currently is controlled by the Federal Energy Administration [FEA].

The FEA has been given great leeway by the courts in the control of imports and allocation. In *Gulf Oil Corp.* v. *Simon* an oil company challenged FEA regulations as violative of the National Environmental Policy Act [NEPA], arguing that no environmental impact statement was prepared prior to promulgation of regulations. The court held that because of Congress' intention for swift emergency action due to the national energy crisis, the FEA's actions took precedence over NEPA. Thus federal activity in the area of fuel allocation has preempted any allocation conflicting with the federal scheme. A designation of necessity to national security pursuant to the war power in any phase of oil policy seemingly would similarly preempt state activity.

The second area in which the war power has played an important role is the generation of electric power. In *Ashwander* v. *Tennessee Valley Authority* the Supreme Court upheld the construction of a dam and electrical generating facilities pursuant to the war power as necessary to national security, even though the construction took place during peacetime. The case demonstrates both the breadth of the war power and the importance of the generation of electricity to national security. From it can be inferred the possibility of war power preemption of state control over electrical generation.

The war power is most controversial in relation to nuclear power. The Atomic Energy Act of 1946 established the Atomic Energy Commission [AEC] to control policy aspects of atomic energy development. The emphasis in relation to power development was shifted to private companies by the AEC retaining power as licensing agency. Under current law nuclear power is controlled at the federal level by the Nuclear Regulatory Commission. Although for a long period states refrained from acting in the area, the role of the states is currently in a state of uncertainty, due to an increasing tendency by state governments to insert themselves in this field, at least as to siting procedures. However, the bases for federal authority in relation to nuclear power—the war power and supremacy clauses—are formidable obstacles for the states to surmount.

Powers Reserved to the States

State energy legislation must be based on some inherent or constitutional power of the state, generally the inherent authority termed the police power. The police power, which is implicitly recognized in the tenth amendment to the Constitution, entails the broad authority possessed by a sovereignty to legislate in furtherance of the health, safety, morals, and general welfare of its citizenry. Few judicial limits have been placed on this power, and a legislative declaration that a law promotes the public welfare generally is sufficient to ensure its recognition as a legitimate exercise of the police power. Thus, in recognition of its broad scope, the police power has been characterized as the power "to promote the public welfare by restraining and regulating the use of liberty and property limited only by constitutional and reasonable judicial requirements." Because of the changing social, economic, and political conditions, it is a flexible power, constantly evolving to fulfill its purpose of promoting the public health, safety, morals, and general welfare.

One of the strongest justifications for the state regulation in the energy area is public safety. For example, the storage and distribution of gasoline may be regulated to protect the state's citizens from danger of personal injury. Similarly, the inherent dangers of operating motor vehicles justify state regulation under the police power despite an unavoidable impact upon interstate commerce. Similarly, the enactment of 55 mile-per-hour speed limits in all states for energy conservation could be justified under the safety aspect of the police power, since the result has been a decrease in highway deaths. Most energy-related regulations, however, are justified as promotive of the general welfare. This is the case, for instance, with laws aimed at conservation of energy resources, an area which is likely to be a major thrust of state energy policy action. These illustrations should demonstrate the breadth of the police power as a justification for state energy legislation and regulations. Were it not for the preemptive effect of federal pronouncements, doubtless the state police power would provide ample authority for virtually any type of energy-related regulation. Thus the primary questions revolve around the scope of federal rather than state power; where federal power does not preclude state activity, state power generally exists.

AREAS OF PRESENT INTERGOVERNMENTAL CONFLICT

Although some areas of energy control fall clearly within the ambit of either state or federal authority, the uncertainties in other areas have given rise to various intergovernmental clashes. Energy development almost inevitably seems to entail threats to the natural and human environment; thus potential for conflict inheres in the growing public and governmental concern regarding both energy supply and environmental protection. The most heated conflicts to date have occurred in relation to nuclear power facilities and development of offshore oil resources. An examination of these controversies is illustrative of the sort of intergovernmental problems likely to arise as the move for energy independence continues, and may provide some guidance to officials seeking to minimize future clashes.

Nuclear Power

The nuclear power controversy currently sparks the most heated debate. Several states, concerned with the potentially devastating effects of malfunction or sabotage, are considering measures to ban or control the development of nuclear power within their borders. At the same time the federal government, in particular the executive branch, has been promoting the case of nuclear power. As yet the constitutional delineations of power have not been finally resolved, although the federal preemptive claim seems to be prevailing in regard to most tested aspects of the nuclear power problem.

It is reasonable to assume that both the state police power and the congressional power to regulate interstate commerce afford sufficient basis for the regulation of the design, construction, and operation of nuclear power reactor. Thus, the demarcation is dependent upon the extent of express or implied preemption currently operative. The revelent federal enactment against which preemption must be gauged is the Atomic Energy Act, the critical provision of which states, "[n]othing in this section shall be construed to affect the authority of any State or local agency to regulate activities for purposes other than protection against radiation hazards." This provision has been interpreted as expressing a congressional intent to endow the federal government with exclusive authority to regulate the construction and operation of nuclear plants, including the discharge of nuclear waste. According to the eighth circuit court, such federal preemption is necessary in order to ensure that industrial energy development is not stifled by overly stringent requirements. Under this reading, the state would be precluded from imposing requirements stricter than those of the federal government. Even under this view, however, a state role might be possible in such matters as the siting of nuclear plants.

A separate question is presented by a total state exclusion of future nuclear plants or even perhaps a conditional exclusion: should exclusion have the same legal effect as regulation? General principles developed in relation to the commerce clause indicate that exclusion would not be permissible if it resulted in an undue interference with interstate commerce or if it imposed an unduly detrimental effect on other states. Commentators have stated, however, "[t]here is no room for any argument that state bills imposing a prohibition or moratorium on the construction of nuclear power plants are not within the intended scope of preemption because Congress did not directly contemplate this type of state 'regulaton' in enacting [section 2021]."

Future litigation of the nuclear issue is certain. It is also possible that future federal legislation may attempt to clarify the area. Despite claims to the contrary, it appears that states may have a role in regulating some aspects of nuclear power plants. The extent to which this regulation will be allowed remains to be determined.

Offshore Oil and Gas Development

Jurisdiction over offshore oil reserves has been subject to continued dispute for over 20 years. Nonetheless, the United States has turned increasingly to development of this resource in an effort to reduce dependence on foreign oil. In *United States* v. *California* the Supreme Court held that the federal government had full dominion over the 3-mile territorial sea and the land thereunder as an incident of national sovereignty. This decision was partially nullified by the enactment of the Submerged Lands Act whereby the federal government relinquished to the coastal states submerged lands lying seaward from their respective boundaries for a distance of 3 geographical miles.

Under the Submerged Lands Act the United States retains control of the land and water of this belt for purposes of commerce, navigation, national defense, and international affairs. The Act indicates that the rights retained by the federal government are paramount to the proprietary rights granted to the states but do not exclude exercise of those rights. The states have power to administer, lease, and develop the submerged lands and the natural resources of the marginal belt subject to the priority of the federal interest in those areas named. These reservations by the federal government are in recognition that the territorial sea is a major channel of interstate commerce with important defense implications, but they do not reduce the states' title to such lands beyond that inherent in the supremacy clause of the Constitution. Thus the Submerged Lands Act granted to the coastal states dominion over the offshore seabed within the territorial sea. The Act expressly declared that its provisions in no way affected federal control over the OCS beyond the marginal shelf. By the Outer Continental Shelf Lands Act of 1953 Congress had declared it to be the policy of the United States that the subsoil and seabed of the OCS are subject to its jurisdiction, control, and power of disposition.

The Outer Continental Shelf Lands Act expressly authorizes the Secretary of Interior to prescribe rules and regulations which he deems necessary for the leasing of OCS lands. This authority has been used to formulate regulations designed to insure that development and operation of oil and gas wells are done in a safe and efficient manner. All oil and gas leases issued under the authority of the Outer Continental Shelf Lands Act are subject to forfeiture for any breach of the rules and regulaitons formulated by the Secretary. Not only does the Secretary have the right to lease OCS lands for oil and gas development, but he also has authority to grant rights of way through these lands for the transport of oil or gas. Such authority gives the federal government the ability to control the location of pipeline corridors up the states' territorial sea. The successful completion of corridors to the shore depends on the coastal state. Thus, the rules indicate that a coastal state may not arbitrarily exclude or unreasonably restrict energy production and transmission facilities. The standards effectively condition grants under the Coastal Zone Management Act on the states' meeting their obligations for energy-related siting within their coastal zones.

The federal government therefore has a tremendous impact on energy-related development through its direct control over the disposition of federal lands. In turn, this federal power can have a strong impact on state land use decisions. Presently the federal government is attempting to coordinate the disposition of federally controlled OCS lands with the affected coastal states' management programs.

POTENTIAL GOVERNMENT ROLES IN DEVELOPING ALTERNATIVE ENERGY SOURCES

Following the 1973–74 oil embargo imposed by the Organization of Petroleum Exporting Countries, attention has focused on developing alternatives to petroleum as a source of energy. In general the potential for intergovernmental conflict appears lesser in regard to solar energy, geothermal energy, wind energy, and energy generated by solid wastes than is true of the traditional fossil fuels or of nuclear energy. This is because development of such energy forms is not known to entail the dangers of nuclear power or the environmental costs of fossil fuel extraction. Correspondingly, the prospects for federal-state cooperation are greater. There are nonetheless legal questions concerning the appropriate role of each level of government in the development of each of the primary alternative energy sources, though the issues differ markedly from those raised by the previously discussed conflicts.

Solar Energy

An enormous supply of energy is received by the earth from the sun. Solar energy is estimated to have the potential for supplying 25 percent of the United States' energy needs by the year 2020. The greatest potential for early utilization of solar power lies in heating, cooling, and supplying hot water for buildings—uses which currently constitute 25 percent of United States' energy consumption. Development activities aimed at converting solar energy into electrical energy also hold promise, though the implementation stage for such systems lies some years in the future.

Although the development and utilization of solar energy could do much to offset present and future energy shortages, initial capital costs to both potential producers and consumers are formidable. State and federal governments thus may find it desirable to offer assistance in the form of financial assistance to research and development, as well as tax incentives for commercial and private utilization. In addition to offering support of this type, governments will need also to prescribe protective standards and other regulatory measures.

Financing research and development is of nationwide importance and logically is a matter for the federal government. Congress has already taken certain steps in this area. The Solar Heating and Cooling Demonstration Act, for example, directs that $60 million be applied to promote the practical use of solar technology. Another statute, the Solar Energy Research, Development and Administration Act, allocated $77 million for research and development of solar energy on a commercial scale. Some states have taken their own initiatives in funding research and development facilities which can provide information on solar energy. Cooperative funding efforts such as these flow naturally from the state and federal governments' mutual interest in the development of clean energy.

Even under present technology, widespread use of solar energy systems for heating and cooling residences and commercial buildings is feasible, and some states may wish to encourage such use due to the diminishing supply of fossil fuels. The most effective tool available for a state to implement such policies traditionally has been the tax incentive. Specifically, exempting the construction and maintenance of solar energy facilities from state sales taxes, ad valorem taxes, corporate taxes, and in some states income taxes will provide a financial incentive to solar energy use. Corporations manufacturing equipment for such systems also could be given tax relief. Several states have already enacted such measures into their tax codes. The federal government, of course, could provide similar incentives through the federal income taxation system, and such proposals are presently being considered by Congress. Because each level of government has its own tax system, intergovernmental conflicts seem unlikely; rather, the coexistence of state and federal measures increases the incentive to produce and utilize solar devices.

The potential proliferation of solar energy users will call for some sort of governmental controls establishing, protecting, and regulating rights in solar power. Obstructions blocking access to the sun, for instance, would render units ineffective or totally useless. Although at common law prescriptive rights to light could be acquired through use over a period of years, many American jurisdictions have abrogated the right to acquire such easements. Nor has any other sort of right to the free flow of light across adjoining lands been recognized, though litigation of this issue has been scarce. If solar users are to be assured a continuing supply of their energy source, therefore, it will be necessary for states to create and define legislatively solar rights as a form of property right. Indeed, establishment of such rights would seem a necessary prerequisite to the consumer's substantial investment in solar equipment. Protection of this investment is clearly within the state's police power. Another area of police power regulation potentially requiring action to permit and encourage solar energy use involves modification of restrictive zoning controls governing residential architecture. Building codes also may require amendment.

Although these areas of regulation are preeminently within state control, a substantial supportive role can be served by the federal government. In 1928 the United States Department of Commerce published a Standard State Zoning Enabling Act as a model for state legislative enactments empowering local governments to establish land use controls. A modification of this Act to protect and encourage solar energy use would both aid states in amending their own laws and promote uniformity among the states. This is only an example of the potential guidance and technical assistance which the federal government, with its vast resources, is capable of providing to the states.

Geothermal Resources

A second energy source inviting cooperative state and federal action derives from the molten mass known as magma, which is usually found 20 miles below the earth's crust. Fissures in the earth's crust permit the magma to approach the surface, enabling man to exploit it as a source of energy.

Since geothermal resources are a complex mix of water, thermal energy, gas, hot rocks, and possibly other mineral byproducts, a fundamental legal problem associated with them is one of classification. Ownership and control of such resources on lands subject to prior mineral conveyance by the federal government are in question due to this lack of definite classification. Different laws deal with ownership and control of the minerals, gas, and water found on lands within known geothermal resource areas [KGRA]. Prompt and beneficial development of geothermal resources is dependent on determining which set of laws is the applicable one. For instance, federal rights in geothermal energy under mineral reservations contained in various conveyances of public land are dependent on this resource being classified as a mineral. If the mineral classification is upheld, however, no established leasing authority for geothermal resources on federally controlled offshore lands will exist.

Courts have varied in their classification of geothermal resources, and have classified them differently for different purposes. None seems satisfactory; having characteristics of water, mineral, and gas, geothermal resources fit neatly into no category. Water is merely a transport mechanism for the energy, and sometimes must be artifically introduced into the system. The steam produced, on the other hand, is a result of the resource and not the resource itself. Nor does geothermal energy have the characteristics traditionally associated with a mineral. Probably the most logical resolution of the classification problem would be a distinct classification of geothermal resources and enactment of separate regulations governing them. Since most of the classification problems arise in the context of federal laws and regulations, corrective action also must take place at the federal level.

The primary problem area involving potentially conflicting state and federal laws involves the presence within a KGRA of lands subject to the jurisdiction of different governmental entities. Under the Geothermal Steam Act of 1970, the Secretary of the Interior has discretion to conserve properly the geothermal pool and to require lessees to unite and operate collectively as a unit. State and privately owned land adjacent to the federal lands within a KGRA is subject to control and regulation by the states. Responsibility for the management of a single geothermal reservoir that underlies lands controlled by separate jurisdictions thus must be assigned.

The problems which might arise due to separate jurisdictional control are well illustrated by the experience of the petroleum industry. The rule of capture has characterized petroleum exploitation in the United States with unfortunate results, each developer, being entitled to whatever oil he could produce, literally raced to extract oil to protect his interest. This resulted in waste, and, on occasion, damage to the underlying oil pool. The rule of capture has recently been tempered by basin management concepts, however, these controls came late to the petroleum industry. To insure the beneficial development of geothermal resources and to prevent overproduction of the field, such controls should be introduced at the earliest possible state of development. The reduced output from a geothermal well due to overproduction can result in a loss of pressure within the well that can preclude the further generation of energy from the source. The uncertainty resulting from this doubt as to the potential duration of the source could discourage a geothermal developer. He must have reasonable assurance that the geothermal resource will support the generating facility for a sufficient period to justify the investment.

Regulations contained within the 1970 Act require compulsory pooling, and unitization in production which allows all lessees of a common pool to share equally in the production. Such a plan seems to be a significant step in solving the problem of overproduction. Some states have taken similar action. New Mexico, for example, has enacted legislation which permits holders of state geothermal leases for the same reservoir to enter voluntarily into agreements to enhance production, with the state regulating production for maximum recovery. However, the discretion is that of the developer, not the state. Consideration should be given to a functional management system, involving both state and the federal governments, that insures to each developer the control over its respective lands, but at the same time, guarantees the proper use and development of the geothermal resource by minimizing waste. A cooperative plan seems to be the most promising scheme since it takes into account the unique nature of the geothermal resource.

A governmental role in promoting geothermal development also seems an appropriate concomitant to the regulatory function. Federal tax incentives that would encourage industrial development of geothermal resources should be made available. Tax writeoffs for geothermal extractive industries, depletion schedules and depletion allowances for geothermal resources, and capital gains treatment for profits would be important economic incentives if offered to geothermal industries. The state could also offer tax incentives that would favor geothermal industries. Property used in the extraction of geothermal resources could be exempted from ad valorem property taxes, and equipment purchased for the extraction could be exempted from sales taxes. Additionally, income realized from the manufacturing and sale of equipment for the extraction of geothermal resources could be exempted from state income taxes.

Wind Energy

Wind energy, another alternative energy source in the development stage, also seems amenable to concurrent state and federal lawmaking. Aside from the obvious difficulty that only certain areas of the nation have sufficient sustained wind velocity to allow the economic utilization of this energy source, the major impediment to prompt implementation of wind energy systems may involve legal questions of aesthetic pollution. The objection to electrical transmission towers as aesthetically degrading would appear to foretell the public reaction to windmill towers; the possibility of a windmill on every other roof will probably be even less acceptable. Indeed, building codes and zoning height regulations on the state and local level may now preclude the installation of windmills or may be so used in the future. Federal and state governments should act cooperatively in this area to test and encourage public acceptance of windmills. State governments, with possible federal assistance, can also make any changes in state enabling laws necessary to allow local zoning and building code changes favorable to wind energy utilization.

Several additional problems arise from attempts to harness wind energy. A difficulty shared with solar energy is the lack of recognized legal interest in the energy source. Courts presently do not recognize any right to the air flowing across the land of another. Unless sufficient spacing is maintained, adjacent units could interfere with one another, thus discouraging widespread utilizaion. Further, the public acceptance problem could be exacerbated if a potential user's right to operate his unit without interference remains uncertain. State legislation recognizing and protecting wind energy rights is the preferable solution; in its absence, local zoning controls can remedy the situation, albeit less effectively.

Other problems arise from the lack of legal standards refining ownership in the atmosphere and its currents. Rights to wind energy from federal and state lands must be determined, and appropriate leasing procedures established. Moreover, possible windmill interference with television and microwave transmissions must be anticipated and dealt with. Construction of other tall structures—electrical transmission towers, skyscrapers, and others—has been allowed even though it interfered with electromagnetic transmissions. State and federal entities with responsibility for communications and energy development should confer regarding this problem and attempt to reconcile the competing interests.

Energy from Solid Waste

Finally, attention should focus on the use of solid waste to create energy, an area which has been the object of considerable recent federal and state attention. Organic waste, which constitutes over half of the total waste generated each year, can produce sufficient energy to replace at least half of present oil imports. Development of this promising energy source depends on interrelated efforts of state, federal, and local governments.

In general, the municipalities are responsible for and bear the cost of collection and disposal of solid waste. This would seem to imply that the municipalities should also be responsible for implementing programs whereby recovery from solid waste would become possible. However, the initial planning and construction costs involved in converting from a disposal system to a recovery system may be prohibitive to the municipalities. Further, the quality of solid waste required to be fed into a processing unit to insure its efficient operation may require the joint operation of a unit by several municipalities, resulting in shared benefits and requiring cooperative planning and development. With no municipality having more authority than another, disputes among the municipalities concerning site location and distribution of the benefits could lead to unnecessary delays in the planning and development of the processing unit.

A plan implemented by the states with the cooperation of the municipalities appears to be a possible solution. A statewide plan would help to insure efficient planning and maximum utilization of solid waste through larger, strategically located processing units. The states could assist also in financing the planning and construction costs of the processing units. The aid of the federal government would significantly add to these cooperative efforts. Unfortunately, however, the federal government presently appears to lack a strong commitment to solid waste recovery, at least in part because waste disposal has been considered a local rather than national matter. The thrust of waste management was redirected from disposal to resource recovery and federal involvement initiated by the Resource Recovery Act of 1970, authorizing the Secretary of the Interior to carry out demonstration projects. Still, the federal effort in this area has not significantly progressed.

The federal role should be much greater. In addition to financing research and implementation projects, the federal government should coordinate overall research efforts, providing technical assistance to state and local governments, providing the necessary incentives for increased use of recycled materials, and increasing the awareness of state and local governments of the potential benefits of energy and resource recovery from solid waste. Should the states fail to begin prompt utilization of solid waste due to economic pressures or convenience, the federal government has the authority and means to overcome these problems. Solid waste is a problem national in scope and interstate in character. Prompt development of energy recovery from solid waste will require an expanded and accelerated federal role. Strong legislation is necessary to insure adequate federal support, guidance, and initiative.

The federal government, in addition, must take steps to make the economics of energy recovery from solid waste more attractive. Although state action toward this goal is also possible, the states acting alone cannot eliminate the presently existing economic disincentives. The problem lies in three primary areas: discriminatory freight rates, federal procurement policy toward products containing recycled materials, and taxes favoring utilization of depletable energy resources.

The cost of transportation may be determinative of whether energy recovery from solid waste can be economical. The marketability of recovered energy will depend on its economic competitiveness with virgin materials used as energy sources. Evidence shows that the freight rate structure discriminates against some secondary materials in favor of virgin materials. Since delivery cost represents a large percentage of the price of solid waste, such discrimination in the rate structure places recovered energy at a serious disadvantage on its economic competition with virgin resources.

A second important factor in ensuring the economic feasibility of energy recovery from solid waste is the marketability of inorganic materials separated during processing; such sales could help offset the necessary cost of processing the solid waste. The federal government, although the largest single purchaser of many United States goods and services, consumes less than 4 percent of gross domestic output. On the surface, then, it would appear that the effects of federal government purchases would be minimal; however, a government program aimed at the use of recovered materials should increase public awareness of the potential for recycling. Moreover, the widespread circulation of federal specifications on recycled material would tend to encourage state and local governments, as well as the private sector, to utilize these materials. Similar purchase policies by the states could add significantly to the development of the recovered energy market. According to the Environmental Protection Agency [EPA], federal procurement regulations in the past have favored the purchase of products containing virgin materials, requiring in certain cases that they be purchased in preference to products containing secondary materials. The General Services Administration responded by instituting a program emphasizing the procurement of products containing secondary materials. This program, aimed primarily at paper products, should be expanded so as to give maximum incentive to potential developers of energy from solid waste.

Finally, changes in the system of tax incentives are necessary. Capital gains treatment for profits, tax writeoffs for extractive industries, depreciation schedules, and depletion allowances favor the use of virgin materials. These allowances promote the use of virgin resources in place of secondary materials, in effect subsidizing virgin material use. The system of tax incentives should be reversed to favor the utilization of solid waste.

REGULATION OF ENERGY DISTRIBUTION

The allocation schemes which attend the energy crisis provided an example of both conflict and cooperation. The federal Emergency Petroleum Allocation Act had specific provisions for a state role in allocating petroleum. In some states cooperation was amicably achieved, while in others the procedures resulted in strong state objections. Since the federal government has exerted authority over distribution, it is likely that in future shortages the federal government may exert even greater controls. Given that these controls will be a result of shortages and that the goal of the states will be to obtain as much fuel for their own citizens' needs as they can, conflict seems inevitable.

The transport of energy falls to a large extent within federal regulatory authority since energy transit involves interstate commerce. Whether by pipeline or other means, the federal government, through the Interstate Commerce Commission [ICC] and the FPC, largely controls the transport of energy. However, there does exisit a role for the states, particularly in controlling the distribution of electrical energy.

Electric Utilities

The electric utility industry is currently undergoing extensive transformation resulting from recent energy shortages, escalating costs, and increased public indignation at rising prices for electricity service. In the current context striking the necessary balance between investor and industry interests on one hand, and consumer interests on the other, has become an exceedingly complex process. Several federal agencies have limited authority over electricity distribution; however, the primary governmental control in this area has traditionally been with the states. State public utility agencies generally have the power to prescribe fair and reasonable rates and charges, classifications, and standards of quality and measurement, and to establish a uniform system of accounting and reporting by each public utility. Further, such agencies oversee repairs, improvements, additions, and extensions to the facilities of a public utility which are necessary to provide adequate service and promote the convenience and welfare of the public. The authority of the states to act in the area of distribution of electricity is well recognized. However, since new and possibly untried methods are called for in dealing with the current energy situation, constitutional limitations on state power should be carefully delineated.

An important source of limitation on state power to deal in the area of electricity distribution is the preemptive authority of the various federal agencies. For example, the FPC has authority over interstate sale of electricity, and requires all public electric utilities to make periodic reports of their operations and accounts. Additionally, it plays an important role in the planning and coordination of regional electric generating facilities. It may order a public utility to connect its transmission facilities with facilities of one or more individuals engaged in the transmission or sale of electrical energy, and to sell or exchange energy with such individuals. In the event of an emergency, the FPC may require temporary connections of facilities and such generation, delivery, interchange, or transmission of electric energy as it decides will best remedy the situation. Another federal agency with responsibilities which affect electric utilities is the EPA. The EPA, concurrently with state environmental agencies, has authority over the environmental impact of electric utility policies. Finally, the Nuclear Regulatory Commission is empowered to deal with the production of nuclear energy.

Thus the federal government maintains a significant level of authority over certain specific regulatory areas related to the generation of electricity. This authority is direct and affirmative, as in the determination of fuels and direct regulation of interstate sales by the FPC, as well as indirect and negative, as in the area of environmental protection by the EPA. Up to this time, however, there has been no agreement among the branches of the federal government regarding the direction a comprehensive regulatory scheme should take. State and local governments and private individuals are left to exercise considerable authority to deal with the evolving electricity conversion problem. Given this option, the states have generally chosen to concentrate on electricity distribution issues, such as rate structures, rather than to confront directly the conversion problem. It should also be noted that the electric utilities themselves maintain considerable control over the equipment used, the proposed sites to be developed, and the fuels to be burned. While the states have considerable power to regulate conversion they have generally failed to exercise this power except in the context of other issues.

Natural Gas Utilities

Natural gas is currently under extensive control by the FPC. Federal regulation began as early as 1938 as a result of requests by states which have been frustrated in their attempts to deal with the vertically integrated industry at the local level. During this early period, the Supreme Court had effectively precluded state regulation of interstate natural gas as being in violation of the commerce clause. States were permitted to regulate only where interstate commerce ended and intrastate commerce began, that is, where pipeline pressure was reduced and gas passed into local distribution systems. This left the states free to control rates charged by distributors to local consumers, but unable to control prices charged by interstate pipeline companies to distributors. The purpose of the Natural Gas Act was to fill this gap between production and distribution in which the states could not act. The FPC was given regulatory authority over the interstate transportation of natural gas, including the power to set "just and reasonable" rates. Direct sales and intrastate distribution are not within the Commission's jurisdiction, although there have been proposals to extend its power into this area.

Thus, states that import most of their natural gas supply must leave regulation largely to the federal government; however, the regulatory situation may face future changes. One of the most controversial issues in regulatory circles today is the question of decontrol or deregulation of the natural gas industry. Advocates of deregulation point to FPC price regulation as the cause of the current gas shortage. There is general agreement that domestic natural gas reserves are sufficient for domestic needs for at least the remainder of the century, given reasonable efforts to locate and produce the gas. Yet, production has not expanded to meet the demand requirements, and the impact of the shortage has been felt primarily by interstate residential consumers, the group regulation is intended to benefit most. It is argued that deregulation would effectively correct the shortage since it would induce exploration and development of supplies not currently economical to develop. Components counter that there are shortages of other petroleum products not subject to regulation; thus, this factor cannot be blamed for the industry's failure to develop available resources. A major point of contention centers on whether the industry would be sufficiently competitive without regulation to operate in a manner not detrimental to the consumer. Proponents of deregulation assert that the industry is "workably competitive," pointing out the relatively low degree of ownership concentration in the production of gas and in reserve holdings for future production. The argument is that without regulation, prices would rise to the marketclearing level and compete with other alternative supplies available to consumers. Opponents of deregulation, on the other hand, are adamant in their position that the industry is not workably competitive and must be regulated to protect consumers from exploitation. Petroleum companies are characterized as approaching oligopolistic control of all energy resources, thereby becoming full-line vertically integrated energy companies. Thus, deregulation of natural gas producers could result in the companies' using natural gas price increases to obtain higher prices for oil products, coal, and other fuels.

The states will be generally affected by any change in FPC policy, including deregulation schemes. Some states are currently using their limited power over natural gas to allocate gas within their borders. If FPC jurisdiction is broadened to include intrastate sales, state power will correspondingly diminish under the supremacy clause. Any national priority scheme established by the FPC would have to be followed by state regulatory commissions in determining end use in individual states. Total deregulation, on the other hand, significantly broadens the states' interest in the distribution and consumption of natural gas in general.

The degree of unhappiness with the program expressed by some states thus gives rise to a suggestion that the states should establish their own allocation system, either to supplement the federal system or to replace it if the Emergency Petroleum Allocation Act expires. The body of federal law on fuel allocation is so extensive, however, that such an independent state system seems inadvisable, and may be preempted. In addition to the fuel allocation act, the Defense Production Act of 1950 and the Natural Gas Act both contain provisions relating to fuel allocation. These statutes further illustrate the pervasiveness of federal control in the area and reinforces the preemption argument.

GOVERNMENT ROLES IN ENERGY CONSERVATION

Since the increase in national awareness of the finiteness of traditional energy resources, the need for additional conservation measures has received considerable attention. Unlike the concomitant effort to develop alternative energy sources, conservation involves areas in which strict delineations of federal and state authority have been drawn over the years. The resulting jurisdictional mix may impede prompt implementation of comprehensive conservation programs, though opportunities for coordination do exist and should be utilized.

Building Construction

In the last 8 years, energy consumed in space heating for commercial buildings has almost doubled. There is evidence to suggest that savings of two-thirds in nominal lighting energies can be achieved by available technology. Making energy conservation an overriding concern in the design, construction, and operation of new buildings could result in a savings of about 40 percent of the energy per cubic foot of space now being consumed. The federal-state balance of control over building construction is somewhat nebulous. Although the state has primary control over matters such as zoning ordinances and building codes, it appears that the federal government, through its spending and taxing powers, may influence energy consumption in buildings in the future. Further, the federal government can influence construction habits by specifications included in such federal loans as those made by the Federal Housing Administration and Veterans Housing Act. Nonetheless, primary control in the area of housing codes resides in the states.

Building regulations are supported by the state police power and, if reasonable, are valid to the extent they promote the common good. So long as the regulation is not arbitrary and tends to promote the public health, safety, morals, or general welfare, it will be upheld. The requisite connection of reasonable regulation and rational relation to legitimate public purpose can be found in the broad public benefits provided by energy conservation. The goal of energy conservation thus is arguably within the ambit of public welfare for which the legislature may act.

The state may lawfully establish retroactive regulations which require reasonable changes in existing buildings to improve energy efficiency. In determining whether a substantive retroactive regulation is reasonable, the essential question under traditional due process notions is whether the public welfare requires retroactive applications and whether the property owners affected would suffer an unreasonable burden as compared with the resulting public benefits. Additionally, under substantial due process restrictions, the end sought by the legislature must be a legitimate public purpose, yet the means must not be unreasonable, arbitrary, or capricious. Generally no rights are violated if the sum required to be spent by the property owner is reasonable under the circumstances. For example, the United States Supreme Court upheld a building ordinance requiring the installation of a sprinkler system costing $7,500 in a building worth only $25,000. In another case, the South Carolina supreme court sustained an ordinance which required the plaintiff to repair his rental property at a cost exceeding $575 for each of the over 100 units he owned. The court felt the ordinance to be reasonable and not a taking of property without compensation. Courts have also upheld energy-related housing code requirements, ranging from a provision mandating room heating facilities to a water heater requirement.

In addition to due process constraints, there are two other limitations on police power energy regulations such as those which would be instituted by a state under its building code. The supremacy clause requires that a state statute yield in case of a direct conflict with an exercise by the federal government of its constitutional powers. The remaining restriction on state statutes is the equal protection clause. Equal protection demands that the law have the same effect on all persons and property belonging to the same class and under similar conditions. "The Fourteenth Amendment permits the states a wide scope of discretion in enacting laws which affect some groups of citizens differently than others." A state statute may not be struck down as offensive of equal protection in its scheme of classification unless it is obviously arbitrary; moreover, except in the case of a statute embodying discrimination so patently without reason that no conceivable situations of fact could be found to justify it, the claimant who challenges the statute bears the burden of affirmatively demonstrating that its classifications lack rationality. This presumption of validity places a heavy burden of proof of harm on those challenging the law, and at least where the government is carrying out an essential public service, the statute may be validated simply upon an affirmative showing of a relation between the ordinance and the public health, safety, or welfare. Despite this broad state authority to clarify, however, a state regulation will be overturned if it is obviously arbitrary and discriminatory.

Pursuant to the commerce clause, Congress could enact a uniform national building code if national uniformity proves necessary to prevent inconsistent local regulation from interfering with interstate commerce. Under present preemption doctrine, however, this alone might not be sufficient to prevent totally state regulation in the area. If federal uniform building codes were to have full preemptive effect, a firm expression of congressional purpose and explicit preemption of state regulation might be required.

At present the most important source of federal standards for both existing and proposed structures is the Department of Housing and Urban Development [HUD]. If liberally construed and administered, the mortgage refinancing authority of the 1974 Housing Act, under a new section, should be used to encourage building improvements conducive to energy conservation. Traditionally, building owners have obtained funds for deferred maintenance, repairs, and rehabilitation by refinancing residential properties every 10 years or so. While institutional lenders no longer supply this financing very readily, section 223(f) can offer owners an opportunity to accomplish repairs; its authority is not limited to older areas or to low or moderate income residents. Its broad language permits HUD for the first time to insure mortgages on existing housing where "substantial rehabilitation" will not be undertaken. Participating owners will be required to make repairs and improvements to satisfy applicable local housing codes and the objectives of the HUD Minimum Property Standards. Such standards could easily include energy conservation requirements.

The impact of existing federal programs is limited, however, by the ability of the states to establish more stringent building standards to be met before local occupancy permits are granted. States generally retain the power to adopt laws affecting the subject of a federal statute, so long as the federal purpose is not undermined. Additionally, in view of the traditional role of the state police powers even a federal uniform building code could likely be viewed by the courts as an unwarranted intervention in local governmental activities. Thus, the federal role in influencing building construction for more efficient energy utilization will probably remain a limited one.

Transportation

Transportation is also a key energy policy area because of its relation to energy consumption. Transportation users depend heavily on petroleum products for their energy. Thus oil policy and foreign affairs are heavily interrelated with transportation programs, as are domestic oil production regulations. Environmental considerations also are interrelated with transportation energy consumption in such areas as vehicle emission standards and the Clean Air Act.

Federal jurisdiction in transportation affairs is similar to federal authority in other energy-related areas. Transportation policy places particular emphasis on the commerce clause and the national power to "provide for the common defense" as the basis for jurisdiction. The federal government exercises broad-ranging powers to insure that interstate commerce is not burdened. Vehicle standards, ratemaking authority, and the like are examples of federal action in pursuit of this power. Providing for the defense of the nation is a constitutional mandate for the federal government to participate in the design and development of transportation facilities. The interstate highway system is an example of a transportation facility built to assist in the national defense. States also have considerable regulatory authority over transportation by virtue of the police power.

Private Transportation.—The use of automobiles is regulated by government through taxes and licensing. There are taxes on the purchase of automobiles and on gasoline, the latter imposed by federal, state, and in some places local government. The gas tax is of particular importance because it is directly tied to automobile use. The consumption of gasoline is relatively inelastic, therefore, present taxes, totalling about 11 cents per gallon, do little to discourage auto use. A large federal tax of perhaps 40 cents a gallon, however, might result in a substantial decrease in auto use, and hence a substantial energy savings.

Presently, the federal government perpetuates America's dependence on the automobile through the Highway Trust Fund. The fund is financed through taxes, including 100 percent of the funds raised by federal taxes on gasoline, diesel fuel, tires and vehicle parts. In the past this fund has been earmarked exclusively for highway appropriations. Even though the fund has now been opened to allow expenditures for mass transit, the bias of the trust fund is clear: "it is unfair and unjust to tax motor-vehicle transportation unless the proceeds of such taxation are applied to the construction, improvement, or maintenance of highways." The federal government is not alone in segregating tax monies raised by gasoline use for maintenance and construction of roads. For example, 6/7 of the gasoline taxes collected in Florida "shall be used for the construction and maintenance of state roads." Thus, at the state level also, the perpetuation of the automobile is statutorily ordained.

A state can regulate goods under its police power without violating the commerce clause only where a mode of interstate commerce is not unduly burdened. Thus, a state would probably be limited in its ability to regulate the sale of autos. Taxes on inefficient vehicles or on fuel-consuming accessories would probably be upheld, however. If the tax imposed correlates to the weight of the vehicles, the tax can be tied to additional maintenance required on roads due to their use by heavier vehicles. However, title III of the Energy Policy and Conservation Act preempts any state efforts which would conflict with automobile fuel economy standards set by the federal government.

The obvious corollary to discouraging the sale and use of inefficient motor vehicles is to encourage the use of more efficient vehicles. Incentives could be established by exempting certain efficient accessories, such as radial tires, from the sales tax. Programs also might be implemented which discourage the use of all automobiles. For example, during the Arab oil embargo, there was a prohibition of Sunday gasoline sales.

Another energy conservation measure that seems particularly susceptible to incentives is encouragement of carpooling. Eighty-two percent of working Americans commute to their jobs in automobiles, many of them driving alone. Over 34 percent of all passenger-car travel in the United States involves commuting to and from work. Incentives aimed at encouraging carpooling can be provided through preferential traffic lanes, parking facilities, and toll rates. Federal funding is available to the states for implementation of carpool incentives through the Emergency Highway Conservation Act and the Energy Policy and Conservation Act.

Mass transit systems provide another effective alternative for decreasing automobile use. The FEA has flatly declared, "public transit is two to four times more energy efficient than the auto." Federal responsibilities concerning mass transit are mainly located in the Urban Mass Transportation Administration [UMTA] which is part of the Department of Transportation. Federal assistance for mass transit, is authorized in the Urban Mass Transportation Act of 1964, most recently amended in 1974. Such assistance, available only to urban areas, is intended "for improving the efficiency of transit services."

Projects which may be authorized under this plan include both capital and operating expenditures.

The states are the more logical level of government to handle mass transit utilization since transportational needs often are regional in nature. No one municipality can cope with the problem, and usually local governments are given only very narrow powers by the state. States have been active in considering mass transit plans; a number of them have also developed carpooling plans, both for government and private employees. States are also asked to coordinate and present statewide plans to meet federal guidelines.

It is local officials, however, to whom citizens turn when their public transit is inefficient, or incapable of getting them to a desired location at a proper time. Local responses have included increased use of buses, carpool lanes, and dial-a-ride. The local role is largely one of planning and implementation. The funds appropriated under UMTA have provided an incentive for local areas to begin implementing such energy conservation measures.

Commercial Transportation.—Commercial transportation involves the movement of freight and people. The authority to regulate interstate commercial transportation lies with the federal government and is based upon the Constitution's commerce clause. State action must not unduly restrict interstate commerce, and regulation must be pursuant to a valid state interest. States have a limited role in measures to conserve energy used in commercial transportation, though the possibility of an unconstitutional regulation of interstate commerce looms large over any such proposal. For example, a state might attempt to promote more efficient commercial transportation by levying taxes upon less efficient modes. If interstate transporters were involved, jurisdiction would be limited to the intrastate portion of the carrier's business. And even then, no action could be taken which would unduly burden interstate commerce. Another argument which might be raised against regulations which vary from state to state is that commercial transportation is so interstate in nature that a uniform national system is the only feasible means of regulation.

Federal regulation of interstate commerce is among the oldest and most well established regulatory powers. The Interstate Commerce Act, passed in 1887, is the nation's oldest statute authorizing direct federal regulation of industry. Principal areas of commercial transportation regulation include air transport, domestic water transport, and surface transport, including rail carriers.

The necessity for energy conservation has altered regulation of commercial transport. In the past era of cheap and abundant fuel, neither the practices of industry itself nor the goals of government regulation stressed the conservation of energy. The purpose of federal regulation was to insure that "[a]ll charges made for any service rendered or to be rendered in the transportation of passengers or property . . . shall be just and reasonable." Shifting freight movement to more energy-efficient modes is now an important objective, as is generally decreasing the demand.

Decreasing demand for freight services cannot be as easily accomplished as decreasing demand for private transportation, however. There is less frivolous use of commercial transportation, and market forces encourage elimination of unnecessary costs. In addition, unlike private transportation, relatively little freight movement is done for pleasure. If an industry or company were impeded in its business by government regulations which prevented it from using freight transportation, a taking issue would be raised. While the use of property can be restricted by government without that action constituting a taking, the prevention of interstate commerce by this type of regulation would probably not be upheld. There are also strong policy reasons for not discouraging the use of commercial transportation. The nation is attempting economic recovery, and freight transportation is basic to business advances. This is an important factor, even when weighed against the need to conserve fuel.

A more promising conservation area involves increasing the efficiency of the various transportation modes. At present, many governmental regulations promote energy-inefficient uses, a notable example being the federal requirement of gateways for interstate truck transport. This requires that common carriers transport goods only according to routes authorized by the ICC, thus frequently causing truckers to travel unnecessary miles. The ICC is attempting to alleviate this situation through the elimination of gateway requirements when a carrier, by using the most direct highway route, can save up to 20 percent of its authorized route mileage. Interestingly, where a greater than 20 percent savings is involved, an appropriate application seeking direct-service authority would be required. Such government regulations requiring activities which inefficiently and unnecessarily use fuel are an anachronism. Regulations must be scrutinized to prevent government, in its regulatory capacity, from causing commercial transport to use methods which are circuitous, uneconomical, and inefficient.

Transportation issues are likely to see some dramatic and far-reaching changes in the near future. Alterations in the petroleum supply and cost situation have already had significant impact on transportation patterns. There are several significant factors which may affect future transportation programs. First, mass transit and rapid transit programs are being increasingly emphasized by the federal government. Environmental concerns, particularly standards imposed by the Clean Air Act, will have to be considered in planning transportation programs for the future. Moreover, because governmental entities are presently short of funds, proposals which require intensive capital expenditures are unlikely to be approved in the future. Finally, without federal leadership, state and local transportation planning suffers from various uncertainties in trying to project future transportation programs.

THE FUTURE OF FEDERALISM IN THE ENERGY ISSUE

A few areas of energy regulation exist which by nature will fall within the exclusive domain of the federal government. Matters relating to foreign affairs are and will continue to be exclusively federal matters. Similarly, national security is an issue of federal concern. The propriety of the exercise of that power may be questioned, however, as to whether a matter claimed to be foreign affairs or national security is properly designated. In the past, for example, the definition of national security as it relates to energy justified the construction of dams and the formation of the TVA. In the future, it may be possible that valid national concerns, such as national defense or security, may be invoked to expand federal authority. In addition, as petroleum becomes scarce, and domestic resources decrease, the actual impact of petroleum policy on national defense will increase. For example, the authority to ration gasoline during World War II was premised on national security; extreme shortages could be utilized to justify such activities even in peace time if the shortages were great enough.

The interstate commerce power, as discussed previously, is also a matter where preeminent federal power exists. Since the limits of this power are at best unclear, the limits of its exercise in the field of energy policy are less than predictable. For example, the federal government is utilizing the commerce power to claim exclusive authority over all automobile efficiency standards. Title II of the Energy Policy and Conservation Act (EPCA) preempts state efforts which conflict with federal fuel standards.

In addition to the federal government's exclusive authority, the states also retain exclusive authority over some issues. For example, the states have the power to make decisions regarding their own purchase of energy consuming items, that is, procurement. In fact, this authority is recognized specifically in the EPCA. Other examples of traditional state authority include zoning, building codes, and utility regulation. To some extent, however, each of these areas is being increasingly affected by federal activity. For example, a federal land use bill which would substantially affect the states is a recurring subject of congressional activity. In addition, a nationwide building code has been proposed. The National Flood Insurance Act of 1968 affects local zoning control. Bills have been introduced which would affect state utility regulations. Each of these cases indicates a continuing possibility of conflict or cooperation between state and federal governments. Each initiative of state and federal government without conscious coordination increases the potential for conflict. To optimize the interaction of state and federal governments, some general principles as to their respective roles should be articulated.

The Federal Role

There are unquestionably distinctions between the motives and goals of the individual states and the concerns of those states collectively as a nation. The more parochial interests of the states may not encompass the long-term national perspective required in energy policy. Therefore, the primary role of national government should be to provide guidance for the citizenry and national welfare as a whole, rather than for geographical sections. This overall guidance should include sources of energy data and information which may be utilized nationwide to avoid unnecessary duplication in research and development in several states. Further, it is the responsibility of the federal government to provide the overall framework within which the states will make their own policy. Without this guidance, conflict would occur not only between the state and federal governments, but also among the states.

The federal government may become increasingly involved in diverse matters relating to energy policy. The degree to which it becomes involved in state-related areas would likely be a function of the degree to which the states have successfully and aggressively pursued their own policies. Currently, the federal government's principal statement of guidance for state governments is the EPCA. However, much legislation is pending in Congress which could affect state energy policy. Because the federal government possesses broad powers, there are very few areas in which there is no potential for federal action. As the energy issue becomes more crucial, it is likely that the federal government's activities will grow and expand into areas which have been more traditionally of state concern, such as utility rates and housing codes. However, if the states themselves act affirmatively to implement energy policies, the federal government may not be required to intervene as substantially as it might otherwise.

The State Role

It is crucial that the states recognize that it is in the best interest of their citizens to utilize the police power to establish energy conservation as state policy. This realization can establish the foundation for utilization of the police power in many areas of concern. There is potential for the states to provide an innovative example for the federal government, and to implement programs which can provide models for other states. There are many areas of concern on the agenda for state action. One way to view the potential for state action is by phases of the energy production-consumption process.

Exploration and Production of Energy Phase.—While obtaining energy resources is a matter of concern to both state and federal governments, the states retain a large measure of control through environmental regulations over exploration within their borders. The states however, are not empowered to limit production to advance their own parochial interests if detrimental to the nation as a whole. The development of resources of the coastal states also relates to exploration and production. Offshore production has been a major source of conflict between the states and the federal government. However, a major attempt at cooperation, the Coastal Zone Management Act, is currently being implemented. While the Act is not aimed primarily at energy policy, it does provide a mechanism through the use of federal funds for state control of coastal zone development, including energy-related onshore activities.

Processing and Conversion Phase.—Changing oil resources into energy is heavily affected by environmental concerns of both the state and federal government. Processing and conversion of both petroleum and nuclear fuels are heavily controlled and regulated. Within this issue the location and siting of nuclear power plants has been and will continue to be an area of conflict. It has been the subject of initiative in the West and litigation in the East. The ultimate extent of state authority to affect nuclear power has not yet been decided under the current statutory scheme.

Under the Clean Air Act, the states are allowed to require the burning of coal with less than one percent sulfur content, thus heavily influencing conversion of coal for electricity. As pressure increases to use coal, new federal standards may be promulgated with the intent to override state restrictions. A new and emerging area of concern is control of conversion of solar energy for electricity. The primary question is who will set standards of performance for solar devices. To this point, standard setting has occurred at the state rather than the federal level. This could result in nonuniform standards among the states, which could cause problems for manufacturers and thus delay the implementation of solar energy technology.

Distribution and Transportation Phase.—The federal government has heavily controlled nationwide allocation under the Emergency Petroleum Allocation Act. It is likely that future shortages and allocation schemes will be heavily controlled by the federal government. Given that these controls are a result of shortages and the goal of states is to obtain as much fuel for their citizens' needs as they can, conflict seems inevitable in this area. Transport of energy falls largely within federal regulatory authority since energy transport involves interstate commerce. Whether by pipeline or by other means, the federal government, through the ICC and the FPC, controls the transportation of energy. One of the major examples of recognition by the federal government of the states' role occurs in the area of energy transportation. The Deepwater Port Act of 1974 grants to the governors of coastal states the right to veto the siting of deepwater ports in adjacent states. Under that Act, the federal government specifically accorded a role to the states in controlling transportation of petroleum through the use of deepwater ports.

Utilization and Consumption of Energy Phase.—The area of use control is the focus of energy conservation. Since energy conservation is of increasing importance ,it is likely that both the state and federal government will be more active. However, it is here that the state possesses the greatest intrinsic authority to implement energy policy. The following is a list of energy-related policies which states should consider in utilization of its police power to reduce the consumption of energy:

(*1*) *Implementation of state zoning and land-use policies which encourage energy conservation.*—This strategy would specifically require states to consider energy matters in the location of developments, industries, and the like. In addition, zoning should be considered for protecting the use of solar devices and for improving industrial siting for optimal use of energy availability.

(*2*) *Utilization of building and housing codes.*—The EPCA has required the states to implement an energy-conscious housing code in order to receive federal funding. Numerous schemes have been devised by the states to implement or to encourage energy conservation in buildings, from tax breaks to direct building code requirements.

(*3*) *Promotion of alternative sources of energy.*—States have the capability to encourage the use of solar energy as well as the utilization of solid waste for production of electricity. In fact, many states have implemented such policies, and the broader their use of these alternative sources, the greater collective national benefit.

(*4*) *Promotion of conservation in transportation.*—States have within their power the ability to improve mass transportation and encourage its use through wise land planning and through encouragement of carpooling, vanpooling, and special traffic lanes. This is another area in which the federal government has directly mandated some state action for the receipt of federal funds.

(5) *Implementation of energy-conscious procurement.*—The authority to affect procurement is specifically recognized by the federal government, and certain states are implementing energy-wise policies. The ability of states to take the lead in consuming energy-efficient products can set both an example and encourage industry to produce such products.

(6) *Restructuring of utility rates.*—Although states traditionally have regulated utility rate structures, the goal in the past has been to ensure a fair rate of return on utility investments rather than control the amount of energy consumed. The rate-setting agencies in many states have adopted or considered rate structures which would tend to encourage the conservation of energy.

Other Policy Considerations

There are many other issues related to energy policy which are just beginning to be raised. Increased efficiency in the utilization of resources such as the use of waste heat, solid wastes, and returnable containers, provide examples of an issue where state-federal boundaries have yet to be drawn. In many of these areas states have taken tentative steps while awaiting some definitive policy from the federal level. For example, the impact of energy policy on disadvantaged groups, such as the aged and the poor, has largely been neglected at both the state and federal levels. Increased attention is being given to this topic in areas such as "lifeline" utility rates, weatherization of low income homes, and mass transportation for the elderly.

The energy issue raises many questions of federal-state roles. The resolution of these issues is likely to cause a major evolution, if not revolution, in the concept of federalism. Assesment of the continuing areas of conflict reveals that, at best, predictions as to future disposition of various issues is uncertain. Yet, the energy issue is not one in which policy can await future clarity. Therefore, state and federal governments should begin to act in the public interest and promote energy's effective use. State governments cannot afford to wait for the federal government to solve their problems. States must act in the interest of their citizenry to alleviate energy-related problems where jurisdictional authority permits. The federal government must recognize the potentially valuable role of the states in the development of energy policy and should encourage state action. This can be accomplished through a comprehensive federal plan which provides leadership and increased certainty, on which local decisionmakers can base their decisions. The federal government should finance innovative pilot projects so that their efficacy can be tested for state implementation. There are areas where the federal government is more capable of policy formulation than the state governments, but there are corresponding areas in which states are better qualified to act. Resolution of areas of effective authority is essential for satisfactory solutions to existing energy problems.

CONCLUSION

The division of authority between state and federal governments has been a matter of continuing concern throughout the history of the country. Because of the complexity of the energy issue, it not only reaches many of the traditional areas of conflict between the state and federal governments, but also creates new ones. As each level of government begins to take more extensive action, the issue of the division of state and federal authority becomes more complex. Moreover, this complexity is intensified by the increasing diversity of energy resources and sophistication of delivery technology. In the near future it is anticipated that state and federal governments will extend their activity in the area of energy policy—the state governments through their police powers and the federal government through its constitutional authority. While it is possible that in some spheres each may operate independently, it is more likely that either cooperation must be generated or conflict will ensue.

THE COAST IS NOT CLEAR FOR ENERGY PLANNING

(By Rice Odell)*

It is hard to conceive a political enterprise more wildly ambitious than the current federal-state program to manage the nation's precious coastal zone. The fitful progress of that program, now more than four years old, is worth examining—not only because of its own far-reaching importance, but because it may forewarn us of problems likely to emerge if some type of national land-use law is enacted.

The coastal program calls for states to develop and then administer coastal zone management plans that meet certain federal conditions—as a prerequisite to receiving federal financial assistance. One key condition is that state plans make some provision for energy facilities. In return, federal agency projects are supposed to be "consistent" with state plans.

Why is the coastal zone program so ambitious and so beset with difficulties? There are three basic reasons. First, the demands on limited coastal resources are numerous and pressing, particularly with the heavy emphasis on increasing energy supplies. Second, the law seeks to reconcile what is inherently irreconcilable—the many conflicting public and private interests that are pushed and pulled in a giant tug-of-war within and among three competing levels of bureaucracy: federal, state, and local. Third, the law provides no regulatory leverage. It relies solely on the inducements of the federal purse, the proverbial carrot.

Typically, the Coastal Zone Management Act of 1972, which established the federal-state program, seeks to serve all masters. It declares a policy of both protecting coastal resources *and* developing them—"giving full consideration to ecological, cultural, historic, and esthetic values as well as to needs for economic development."

The Office of Coastal Zone Management (OCZM), in the Commerce Department's National Oceanic and Atmospheric Administration (NOAA), has interpreted this schizophrenic mandate with expressions of policy such as this:

"It must be recognized that not all development or activity in the coastal zone can or should be halted. As long as these determinations are based on sound information and processes which reflect the value of the natural environment, a process for determining where development should go, as well as where it should not, can be environmentally beneficial, for the designation of specific areas for development will focus and restrict such activities to carefully chosen sites. This will reduce the development pressures on other environmentally sensitive or valuable areas." [1]

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* From the Conservation Foundation Letter, a monthly report of The Conservation Foundation, February 1977. The foundation describes itself as a private, non-profit research and communications organization which "encourages wise management of the earth's resources." References appear at the end of the article. Reprinted by permission.

The basic thrust behind the 1972 act was a concern for environmental protection. But with extensive amendments signed into law on July 26, 1976, Congress changed the rules of the game, seeking to lay on OCZM and the states a heavy energy responsibility. The emphasis on energy—or the federal pressures for energy development—in setting coastal zone priorities has been hard for some states and some citizen groups to swallow. It has worsened a political climate already full of suspicion among federal, state, and local governments, and already rife with the resentment of property owners uptight about *any* government planning or interference.

For example, California opposes a terminal for Alaska oil at Long Beach. There has been vigorous opposition to certain oil leasing off the California, Alaska, and Atlantic coasts, to a liquified natural gas terminal in Chesapeake Bay, to an oil refinery at Eastport on the coast of Maine, and so forth.

How does the Coastal Zone Management Act seek to resolve the inevitable conflicts over issues such as energy development? To qualify for a program development grant, a state program must include "a planning process for energy facilities likely to be located in, or which may significantly affect, the coastal zone, including, but not limited to, a process for anticipating and managing the impacts from such facilities."

In its proposed regulations for implementing that requirement, NOAA says the states would be "*encouraged* to develop . . . procedures for assessing need/demand projections" and for "allocating these needs among coastal and inland locations." NOAA explains that these procedures would not be *required* "because it is felt (they) would be beyond the capability and purview of coastal management programs at this time."

The states would be *encouraged* to develop methods for "determining site suitability of alternate locations for particular facilities." They would be *required*, however, to include a procedure for assessing impacts of energy facilities and techniques for coping with these impacts.

In order to get a program approved and receive federal grants to administer it, the law says a state must see that its program provides for "adequate consideration of the national interest involved in planning for, and in the siting of, facilities (including energy facilities) which are necessary to meet requirements that are other than local in nature."

The approval of a state program triggers another provision of the law which is designed to compensate the states for looking after the national interests. That is the so-called "federal consistency" provision, stating that federal agencies undertaking or supporting any project directly affecting the coastal zone must ensure that the project is *consistent* with approved state management programs, "to the maximum extent practicable."

Antoher provision deals with activities requiring a federal license or permit, and with state and local government applications for federal assistance under other federal programs affecting the coastal zone (for example, the flood disaster protection program). Basically, these activities also must be consistent with an approved state program. However, there is a catch:

The Secretary of Commerce can overrule a recalcitrant state, requiring it to accommodate an energy facility—even if that development is incompatible with the state's management program. To do this, the Secretary need only find that the development is consistent with the law's "objectives" or is necessary "in the interest of national security." (One can expect much squabbling over the definition and application of these terms.)

Clearly, the federal government has the upper hand in dealing with a state that balks at a project. However, it should be remembered that a state can simply withdraw from the program if it wishes. Also, as the OCZM noted in connection with the proposed coastal program for the state of Washington, "The existence and approval of an explicit procedure will protect the state from the capricious imposition of actions or projects by federal agencies in the name of the national interest." [1]

This state leverage is buttressed by language in the law requiring extensive consultation and coordination, between state and federal agencies.

The Secretary of Commerce's power to overrule a state remains paramount, but the law further provides that in case of "serious disagreement" between a federal agency and a coastal state in the development or administration of a coastal management program, the Secretary, with the cooperation of the Executive Office of the President, shall seek to mediate the differences. (If the administration of a state program is involved, public hearings must be held in the local area concerned.)

Then if the mediation effort fails, and the Secretary still concludes that an activity is consistent with the law or is necessary for national security, the state can challenge that determination in court.

Some state officials have said they are hopeful that when state plans are approved, the OCZM will assert some authority to keep federal activities from conflicting with those plans.

The OCZM says it hopes to avoid the worst confrontations by having federal agencies participate fully and harmoniously in program development, so that needs and problems can be addressed early and cooperatively, and essential information can be exchanged. (States are required to provide relevant federal agencies with "the opportunity of full participation.")

However, some states have not done so, according to a General Accounting Office report.[3] A number of federal agencies recommended that Commerce reject Washington State's proposed plan on grounds they were not given a chance for meaningful participation and on grounds there was inadequate consideration of the national interest in energy facility siting. (Washington's program has since been revised and is the only state program approved so far.)

GAO also noted that some federal agencies have been slow and ineffective in meeting their own participatory responsibilities.

On the whole, the OCZM reasons that even if the procedure does not work too well it "should lead to the more deliberate and thoughtful and less fragmented and wasteful siting of such facilities in the nation as a whole." [1]

Related to this federal-state interaction is pending legislation to reform the whole outer continental shelf leasing process. This legislation was agreed to by Senate and House conferees at the end of last year's congressional session, but it was threatened with a veto and failed to win final House approval by four votes. Bills identical to the conference bill have been reintroduced.[4]

The legislation would expand the states' right to key information, and would somewhat enhance the state's role in OCS decision making. It would allow the establishment of Regional Outer Continental Shelf Advisory Boards to work with federal agencies responsible for OCS activities. Any recommendation by such a board or by a governor concerning a proposed lease sale, or a proposed development or production plan, must be accepted by the Secretary of Interior unless he determines that it is not consistent with national security or the overriding national interest.

In addition to federal-state relationships, the Coastal Zone Management Act specifies procedures for interaction between states and local governments or regional agencies. State coastal management agencies, which can allocate their grant funds to local governments, must be provided extensive authority to ensure that local regulations and decisions on coastal land and water uses "do not unreasonably or arbitrarily restrict or exclude those uses of regional benefit."

A "use of regional benefit" is defined as one that "typically provides benefits to a significant area beyond the boundaries of a single unit of the lowest level of local, general-purpose government."

As with the procedures for federal-state coordination, the law calls for extensive consultation and cooperation between the state and local agencies, as a condition of state program approval. Also, if a state agency proposes to implement any decision that would conflict with a local zoning ordinance or decision, it must notify the local government and allow it a one-month comment period.

In the 1976 amendments, Congress authorized $464 million in planning and administration grants for the states over the next four years. It will not necessarily appropriate that much. (By the end of 1976, the OCZM had awarded $36.2 million in planning grants.)

The amendments also establish a Coastal Energy Impact Program to help states and communities deal with the economic, social, and environmental consequences of coastal energy development, including the provision of additional public facilities and services. For this program, the law authorizes a variety of loans, guarantees, and grants totaling up to $1.2 billion over 10 years.

Most of the impact money represents a brazen inducement to boost OCS energy production. This is particularly true of $400 million in grants based on a statutory formula that measures OCS activity. (Alaska, which is being brought into line, and Louisiana, which is very much on-line, will be the chief beneficiaries of the $1.2 billion.)

Some skeptics have said they fear the lavish funding will *encourage* the siting in coastal zones of facilities that should be located inland—such as storage areas or refineries. Environmental groups and others have been fighting for safeguards to ensure that facilities are located away from the coast if at all possible.

Although all 30 coastal states and three territories are nibbling vigorously at the federal government's financial carrot, state commitments to the coastal zone program vary widely. "Some states are just barely going through the motions, with no support from the governor or the public," says Cary B. Hinton, a costal zone management consultant to Baltimore County.

California, however, already had plunged aggressively into coastal management. It needed no federal inducement to create the necessary public concern; the state is glad to get the money to make its program more effective. On the other hand, South Carolina and some other states seem at times to have taken the money, then bitten the hand dispensing it.

Last year, South Carolina Governor James B. Edwards twice vetoed coastal tidelands bills passed by the legislature: At one point he disparaged the legislation as a "land-use planning bill" under which bureaucrats could tell people what they can do with their property. He said it would allow the federal government to plunge its hand "into the very viscera of South Carolina." [5] Edwards—who owns a share in a coastal island himself—said he would be satisfied with a bill that had no ties to Washington—a concept that obviously flies in the face of the federal law's premises.

As this was written, the legislature was at work on a strengthened coastal management bill. Supporters figure Edwards is certain to veto again, but hope for legislative override. Meanwhile, South Carolina has received $897,257 in grants from the federal government for three years of planning. It is expected to apply for a fourth-year grant under a 1976 amendment to the law giving states an extra year if necessary to complete approved programs.

Maine provides another illustration of the sometimes politically painful evolution of a plan. Initially, public opposition was very strong. The plan was seen as a threat to local community management prerogatives; citizens claimed they had too little chance to help develop the program; and there was concern about financing at the expiration of federal funding.

So strong were the objections that Maine's governor withdrew the state's application for plan approval and ordered a reorientation of the program. He noted the "considerable controversy" over whether the preliminary application would "truly represent the needs or the desires of the people of Maine or whether it was more representative of individuals who feel privileged or that they have a divine right to control the lives and/or destinies of a majority of the people." [3]

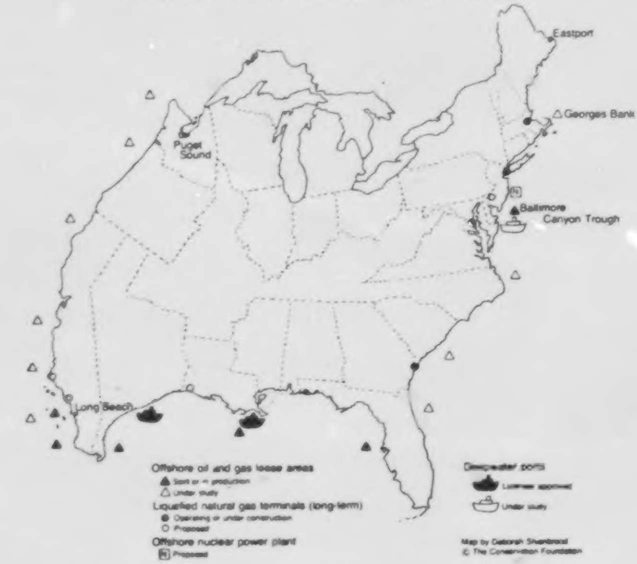
Now, however, OCZM feels there is much greater receptivity, in attitude, partly the result of increased involvement by local officials. A new plan is expected to be ready around mid-year, and the governor may support it, observers feel.

If the federal carrot induces so much indigestion in states such as South Carolina and Maine, one can imagine the frenzied reaction to a stick.

Still another problem impedes the effectiveness of the program. That is the absence of a coherent national energy policy on which states can rationalize the need—or lack of need—for energy facilities. The states can't make energy policy, or assess national energy demands.

A recent study by the congressional Office of Technology Assessment voices many of the doubts raised by the general policy vacuum.

A COASTAL VIEW OF THE UNITED STATES


Eastport
Georges Bank
Puget Sound
Baltimore
Canyon Trough
Long Beach
Offshore oil and gas lease areas
▲ Sold or in production
△ Under study
Liquefied natural gas terminals (long-term)
● Operating or under construction
○ Proposed
Offshore nuclear power plant
Proposed
Deepwater ports
License approved
Under study

Map by Deborah [illegible]
© The Conservation Foundation

This slightly myopic, coastal manager's perspective of the United States shows much of the widespread energy activity taking place or proposed along the nation's shoreline. Except for the location of import terminals for liquified natural gas (LNG), the map does not identify the many onshore areas that would be impacted by industrial complexes to service and support offshore activities. Nor does it identify the nuclear and other power plants sited or planned on the coast. It should be kept in mind, too, that Alaska is almost ringed by areas proposed for oil leasing. (Tracts in the North Gulf of Alaska have been sold.)

The Department of Transportation has said it will issue licenses for two planned deepwater ports—the Seadock port off Freeport, Texas, and the LOOP port off Louisiana. As this was written, the sponsoring companies were deciding whether to accept conditions imposed by DOT. Several other deepwater port proposals have been studied, principally one that would be located in Delaware Bay.

Major LNG terminals already receiving imports or under construction are at Everett, Mass., Staten Island, N.Y., Cove Point, Md., and Savannah, Ga. Applications have been filed with the Federal Power Commission for terminals in Gloucester County, N.J., Lake Charles, La., and Port Hueneme, Calif. Several other LNG terminals have been proposed, and a number of ports, such as Boston, already import LNG under short-term licenses.

"For example," it says, "can the United States proceed indefinitely without (a) a formal process for determining total energy needs and (b) calculating the share of those needs that should be provided by OCS resources? That allocation, rather than the existing program for leasing maximum acreage in the minimum number of years, could become the guide for future leasing programs. It is also important to consider whether the United States can proceed indefinitely with offshore developments for oil and natural gas and other seabed resources, fisheries, and commercial activities, without a formal process for reconciling conflicts not only among the uses but between those uses and their impact on the ocean environment."

At another point the study, which deals with offshore energy development in the mid-Atlantic, has this to say: "Reduction of energy consumption could offer long-term advantages, but there are no specific plans at the state or national level for an energy conservation program that might eliminate the need for the energy supplies which would come from one or more of the proposed offshore systems." [2]

In the absence of policy, the energy cart sometimes gets put before the coastal planning horse. For instance, on January 17, former Commerce Secretary Elliot L. Richardson announced a $920,000 coastal zone planning grant to Alaska. Among the purposes of the money: to designate coastal areas of particular concern, to help local governments develop local coastal management programs, and to provide funds so local governments can determine the onshore impacts of OCS energy development.

The following day—with only two days left in office—former Interior Secretary Thomas S. Kleppe announced the sale on February 23 of oil and gas leases on 683,182 acres in the Cook Inlet of Alaska's outer continental shelf. This decision left open the method by which crude oil would be transported to shore. That determination, said Interior, "is to be made later, based on environmental and technical analysis at that time."

Thus do energy activities precede and preclude thorough analysis and planning. As it happens, however, new Interior Secretary Cecil D. Andrus recently cancelled the Cook Inlet lease sale, at least temporarily, so he can evaluate the program.

State officials have complained about the fragmentation of OCS functions between the Interior Department and the OCZM, and the absence of clear lines of responsibility. This is symptomatic of the absence of an overall national policy on energy supply needs as well as of specific policies on individual state responsibilities for meeting demand and siting facilities.

States sometimes have difficulty obtaining information on reserves, explorations, leasing plans, and the like. The OTA report says that Interior has refused—on the ground it is proprietary information—to share with state officials the kind of seismic data which would give them an early warning about the possible location of major exploratory activities and thus about potential coastal impacts. "Delaware officials," said OTA, "were told by the OCZM that they could use federal grants to pay for the data and interpretation which the Interior Department declines to share with them." [2]

Another embarrassment from inadequate planning is the surplus of oil from the Alaska pipeline that is expected to start building up in California in 1978. (In the running debate over what to do with it, one option is export it to Japan in exchange for oil from the Middle East.) [7]

In many cases, of course, it is too early to gauge the extent of energy development, so that a coastal zone plan is drawn up with a large gap. In a pre-draft plan issued for public review last December, Massachusetts officials included a footnote explaining that the energy section "does not address OCS facilities because, in the absence of exploration drilling, it is not yet possible to determine whether and where such facilities might be located."

Some will say that the coastal zone management program is a waste of taxpayers' money, money poured into states and localities in the vain hope they will develop and implement responsible plans for their coastlines. They will see it as one more nefarious governmental infringement on private property rights and local decision making. Or as a device to seduce states into acceptance of undesirable energy facilities.

If there is truth in these critical assessments, the coastal zone management program also can be considered a noble and necessary experiment. It is noble simply because it is designed to derive the greatest benefits from the great coastal resources. It is necessary because many of these resources are threatened by inappropriate and damaging development, and because it is important to manage them under a system that considers federal, state, and local interests and perspectives.

Coastal areas, so highly valued for their beauty and their biotic and recreational resources as well as their development potential, seem likely to stir up more citizen concern than many of the inland areas that would be targeted by a national land-use bill.

If protection of inland areas does not generate enough grass-roots support, implementation of a land-use law may not be politically feasible.

"The coastal zone program at least has the virtue of being geographically specific, and dealing with land forms that have inherent values everybody understands," says Charles E. Little, of the Library of Congress' Congressional Research Service. "If that is being fouled up, what would you expect from some vague program that involves everybody planning their hearts out?"

One answer, he notes, is more issue-specific legislation—for example, to protect agricultural lands, floodplains, outstanding or environmentally critical areas, and the like. "One must look with a gimlet eye at the grand programs," Little says. "We should pick the targets and go after them." He says he fears that while the planners and lawyers struggle along, a lot of places will be lost to development.

Another warning comes from Marvin Zeldin, an environmental consultant and writer: "What is most likley to emerge in too many states is a coastal zone management plan that embraces the status quo: business and development as usual, with only token lipservice to noneconomic values. . . . Worse yet, in too many states the public may be lulled into greater complacency because of the existence of 'a plan' for coastal areas, no matter how poor the plan." [8]

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7. The problem is discussed at length in *Not Man Apart*, mid-February 1977, and *Audubon*, January 1977.

8. *Journal of Soil and Water Conservation*, January-February 1977.

D. Coal From Public Lands: How Accessible?

FEDERAL LEASING: THE NEED FOR A PERSPECTIVE

(By Courtland Lee and David Russell)*

THE PRESENT DILEMMA OF FEDERAL LEASING

As settlers began occupying the nation's land, federal policy evolved more or less consistently toward the goal of maintaining mineral resources within federal control. The twofold purpose: to generate a source of public revenue, and to prevent monopolies by private parties.

To implement federal policy, legislation (some of it going as far back as a century ago) has assigned the task and responsibility of "conservation" to such agencies as the Bureau of Land Management and the US Geological Survey. Historically, the term "conservation" was recognized to mean: *intelligent, wise utilization* of the resource—and not merely a saving of it.

Land classification was, and still is, the method to gain the necessary knowledge for conservation or wise use of the nation's resources. In fact since 1879,[1] the US Geological Survey has been classifying land according to all the available information about leasable minerals. Traditionally, this vital information has been used simply to determine whether the federal government should retain mineral rights in areas where title to federal surface land is sold or exchanged.

The first step in the classification procedure has often entailed the withdrawal of land from entry, exchange or sale, until an estimate can be made of the extent of each mineral resource. When that estimate has been arrived at, and a "workable" deposit has been identified, the land is classified as a "leasing area"—and it can be leased only through a competitive bidding process.

Federal lands officially classified as having *no known deposit* of a particular mineral may (in some cases) become accessible to interested parties via the prospecting permit; if the holder of such a prospecting permit succeeds in finding a deposit, he is entitled (in some cases) to a "preference-right lease."

We have given this brief description about some of the conditions leading to the issuance of competitive leases and preference-right leases because (a) we want to emphasize that conservation, land classification, and land withdrawals *are not new activities* dreamed up by bureaucrats in recent years; and (b) we want to place within a legal-historical context our next discussion regarding the current status of federal leasing.

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*From Mining Engineering, Vol. 29, May 1977, p. 23–34. Mining Engineering is a publication of the Society of Mining Engineers. Courtland Lee is a mineral leasing specialist and David Russell is a mineral economist. Both are with the Bureau of Land Management, Department of the Interior. Footnotes appear at the end of the article. Reprinted by permission.

[1] Act of March 3, 1879, Title 43 of US code section abbreviated. (43 USC 31), supplemented by Reorganization Plan No. 3 of 1950, 43 USC 1451, and 203 Departmental Manual No. 1, Secretarial Order 2948.

Uncle Sam's Monopoly of Leasable Minerals

During the 19th century, Congress passed various land-disposal and homestead laws to induce Americans and the millions of newly arrived immigrants to settle in the West. These laws, in effect, gave our forefathers free homestead land requiring only nominal filing fees.

Several million acres of coal land, however, were excluded from the homestead or disposition laws. Thus, during the 1860's, coal land sold from \$1.35 to \$2.50 per acre and, after passage of the Coal Land Act of 1873, it became the highest priced federal land offered for sale, averaging from a minimum of \$10 per acre for areas more than 24 km (15 miles) away from a railroad to \$20 per acre for areas within 15 miles of a railroad.

In 1906, the homesteading and disposal of known coal lands was discontinued. This was brought about by a strong movement to save the resources and prevent acquisition by presumed private monopolies. In addition, the government could thereby carefully control these resources and generate greater revenues by leasing the coal rather than homesteading or selling it. But to lease it, government had to have some idea of the value of the land—i.e., the land had to be classified or identified according to its leasable minerals. This is how, in 1906, for the purpose of classification, the federal government began the first of many executive withdrawals of coal land.

By such executive orders between 1906 and 1907, government withdrew from disposal under the homestead laws 271 000 km^2 (67 million acres) and reserved them for classification and appraisal of coal values —which included most of the known western coal occurrences at that time. Withdrawals of coal lands were followed in 1908 by withdrawals of almost 20 000 km^2 (5 million acres) of phosphate and 18 000 km^2 (4.5 million acres) of oil lands.

All this acreage was eventually classified—and those early classifications have been modified and reworked continually to the present time. The classified minerals (alias, the mineral estate) were retained under federal ownership, and the surface (alias, the surface estate) was reserved for private use.

Table I shows the acreage that has been patented from the mineral estate owned by the federal government.

Table 2 shows the different types of classification now existing for a number of important leasable minerals.

But the degree of control exercised by the federal government greatly exceeds the acreage shown on Tables 1 and 2. The reason? Since checkerboarding and complex ownership patterns are often the rule rather than the exception, many mining operations must include at least some federal property. In addition, the federal government owns more than 2 840 000 km^2 (700 million acres) of surface *and* minerals, mostly in the Western States and Alaska.

We estimate that the federal government owns 70 percent of the coal as well as equivalent or greater amounts of other leasable minerals in the western half of the U.S. (see Fig. 1). Significant deposits of federally owned eastern and Alaskan coal are not shown in Fig. 1; and precise data for federal vs. nonfederal mineral ownership are not available.

TABLE 1.—*Patents issued with minerals reserved to the United States through 1975*

	Acres
All minerals	39, 450, 002
Coal	16, 217, 914
Oil and gas	3, 799, 205
Phosphate	414, 083
Oil, and gas and other	1, 109, 329
Miscellaneous combinations	2, 293, 221
Total	63, 283, 754

Source: Public Land Statistics 1975, U.S. Department of Interior.

TABLE 2.—FEDERAL MINERALS LAND CLASSIFICATIONS, WITHDRAWALS, AND LEASES (ACRES)

Commodity	Available Federal leases[1]	Uncertain PP and PRLA's[1][2]	Present potential		Classified mineral[3]	Withdrawn for classification[3]	Future potential		Percent of total domestic production from federal leases (1975)	Percent of domestic production supplying domestic consumption (1975)
			Known leasing areas defined—in process				Prospectively valuable[3]	Prospectively valuable estimated federal surface[4]		
Coal	797,555	609,438	14,239,017 [5] 9,878,000		40,938,903	20,470,929	349,971,002	100,000,000	7.2	100
Phosphate	92,380	88,193	40,393	2,560	360,742	1,620,301	30,531,093	5,600,000	11.8	100
Potash	236,824	29,869	308,620	114,398		9,411,382	80,927,661	17,000,000	87.8	[6] 51
Soda ash										100
Sodium	135,547	98,286	287,904	567,020	625,031		267,425,845	45,000,000	58.9	[7] 86

[1] Data through end of 1975 (source: USGS Annual Report, 1975).
[2] PP—prospecting permits; PRLA's—preference right lease applications.
[3] Includes state, private, and Indian lands.
[4] Figure represents a percentage by State of only Federal surface ownership. An actual survey including the 63,000,000 acres of Federal mineral estate for these categories does not exist. Inclusion of the subsurface estate should considerably increase the Federal ownership indicated in this column.
[5] Federally owned coal in Known Recoverable Coal Resource Areas (KRCRA's).
[6] 33 percent in 1976 estimated by Bureau of Mines.
[7] Sodium sulfate.

TABLE 2a.—OTHER FEDERAL MINERALS (ACRES)

	Leased	Prospectively valuable[1]
Asphaltic material, tar sand	3,890	2,600,000
Oil shale	20,400	9,000,000
Oil and gas (onshore)	80,573,447	375,000,000

[1] Estimated Federal surface.

TABLE 3.—LAND HELD UNDER FEDERAL MINERAL LEASE BY COMMODITY[1] (ACRES)

	1968[2]	1975[3]
Coal	690,804	797,555
Phosphate	98,516	92,380
Potash	274,969	236,824
Sodium	140,498	135,547

[1] Other commodities leased only on acquired lands are not shown.
[2] Public domain only (43,586 acres of leased acquired land were not recorded by commodity at this time).
[3] Includes both public domain and acquired land, as of Dec. 31, 1975.

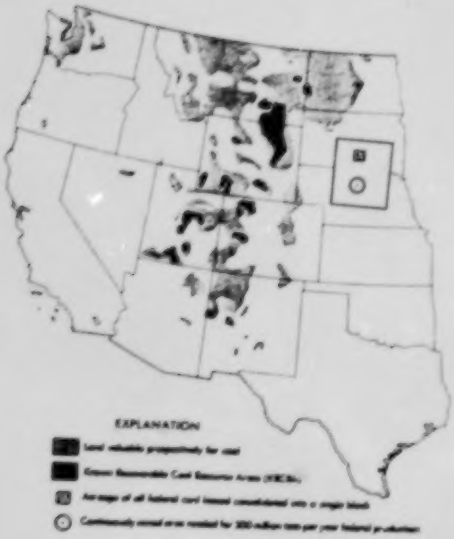
Federal Leasing Today = Zero Leasing

Considering the federal government's control over mineral land, the task of making such land available for leasing becomes crucially important. A managed mineral leasing program requires consistent and rational policies. Unfortunately, judging from federal leasing trends of the past ten or 15 years, such policies are either nonexistent or, if they exist at all, they don't reflect any effective management. Here is the evidence:

Since 1961, the acreage made available through competitive-bid leasing for coal, potash, phosphate and sodium has fluctuated sharply and erratically from year to year while moving in a discernible declining pattern (see Fig. 2), causing widespread uncertainty regarding the alleged availability of federal minerals. For instance, after reaching a peak of 385 km² (95,000 acres) leased competitively in 1968, competitive leasing plunged to *zero* in 1969 and to minimal levels at present. This unsatisfactory situation, largely brought about by the interpretations of the 1969 National Environmental Policy Act, is likely to continue until more rational onshore leasing policies are developed.

Since 1968, the total acreage under lease for phosphate, potash and sodium has actually *decreased*. Coal acreage under lease has increased by about 15 percent *in nine years*.

The acreage made available under preference-right leases, also called "noncompetitive leases," has declined sharply from the 1968 peak of about 1100 km² (280,000 acres) to 11 km² (2782 acres) in 1975 (see bottom graph of Fig. 3)—while the acreage under prospecting permits has undergone a corresponding decline (see upper graph of Fig. 3). The vast amount of land under prospecting permits—2865 km² (708,000 acres) in 1975 for coal, potash, phosphate, and sodium—is essentially meaningless because, to repeat, only 2782 acres of land became available in 1975 through prospecting permits ripening into preference-right leases by discovery of valuable minerals.

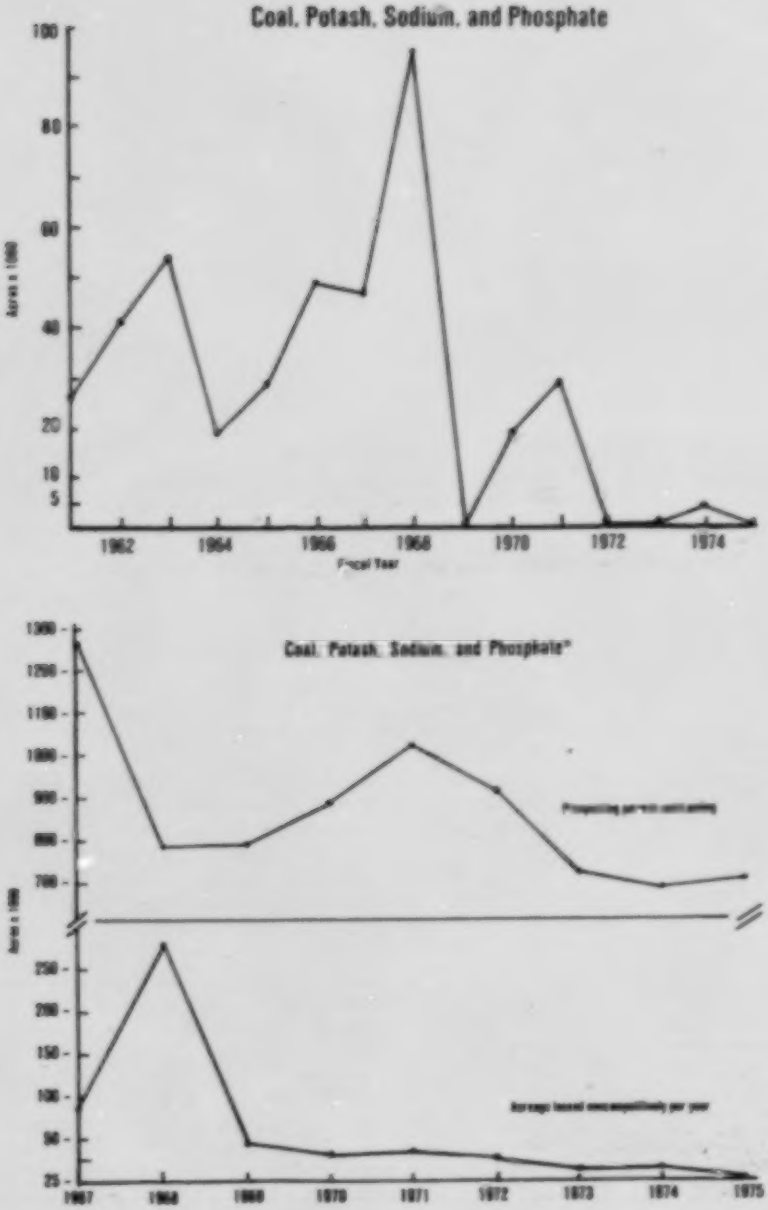

EXPLANATION
Land valuable prospectively for coal
Known Recoverable Coal Resource Areas (KRCRAs)
Acreage of all federal coal leases consolidated into a single block
Continuously mined area needed for 200 million tons per year federal production

The dot within the circle illustrates an estimate of the amount of federal surface continually disturbed by 100 surface mines producing 200 million tons of coal per year. Assumptions include: two years lapse time for reclamation, 175 acres of plant and equipment for each mine, 17–32 acres per million tons per year production (43.6 million tpy of coal was produced from federal leases in 1975). At this rate, the dot will consume the resource moving roughly three-fourths its diameter every two years. This would speed up in some shallower basins and slow to over ten years in the Powder River Basin, 80% of which is federally owned coal land.

FIGURE 2.—Acreage leased competitively per year, public and acquired lands; coal, potash, phosphate, and sodium.

Noncompetitive leases have traditionally been issued outside of the so-called Known Leasing Areas, i.e., outside of areas exclusively reserved for competitive leasing. As we mentioned earlier, the first step in acquiring a noncompetitive lease has been the issuance of a prospecting permit; then, if the holder of a prospecting permit makes a valuable discovery, he is theoretically entitled to obtain a preference-right lease because, after all, he has spent his own money to find a deposit in an area where no deposit was known to exist according to the U.S. Geological Survey. (This was changed for coal after passage of the 1976 Amendments to the Mineral Leasing Act: today, coal leases may be obtained only via competitive bidding.) Incidentally, thanks to prospecting permits, the government has obtained much of the valuable geological data used in the classifications shown on Table 2.

One might assume that since competitive leasing has been sharply curtailed during the last decade, noncompetitive leasing from the large pool of permit acreage would make up some of the shortfall. But this is clearly not the case, as indicated by the low level of noncompetitive leasing since 1969 (Fig. 3). Reasons for this decline in noncompetitive leasing could be attributed to long delays in processing applications for preference-right leases, changes in regulations defining what constitutes a valuable discovery—and, in many cases, competent work by the Conservation Division of the US Geological Survey reserving the valuable minerals for competitive leasing.



*No prospecting permits recorded in public land statistics.

FIGURE 3.—Prospecting permits and noncompetitive leasing; coal, potash, phosphate, and sodium.

Federal Coal: Myths and Reality

Because of the decline in domestic oil and gas production since 1970, federal coal has become a much publicized solution for the nation's worsening energy problem. As things stand, *can* federal coal be a solution? Let's look at some pertinent facts.

(a) Since 1971, the acreage of federal coal under lease has languished at about 3200 km² (800,000 acres)—or 0.8 percent of the (100 million acres) of federally owned land prospectively valuable for coal (see Fig. 4). By contrast, six Western States have issued coal leases for about 5700 km² (1.4 million acres) on state land; and another 1200 km² (300,000 acres) are under existing coal leases on Indian land. Thus, the total acreage under lease from state and Indian lands is more than twice the acreage made available under federal leases—even though the federal government owns much more classified coal lands, including most of the exceptionally rich Powder River Basin in Wyoming.

(b) The 0.8 percent of the classified federal coal acreage is available in scattered leases acquired by coal producers and would-be coal producers prior to 1973. Most of this leased acreage, incidentally, was issued noncompetitively, meaning: it was issued outside of those "highgrade" areas that are exclusively designated for competitive leasing. Obviously, some of these noncompetitive leases will never become

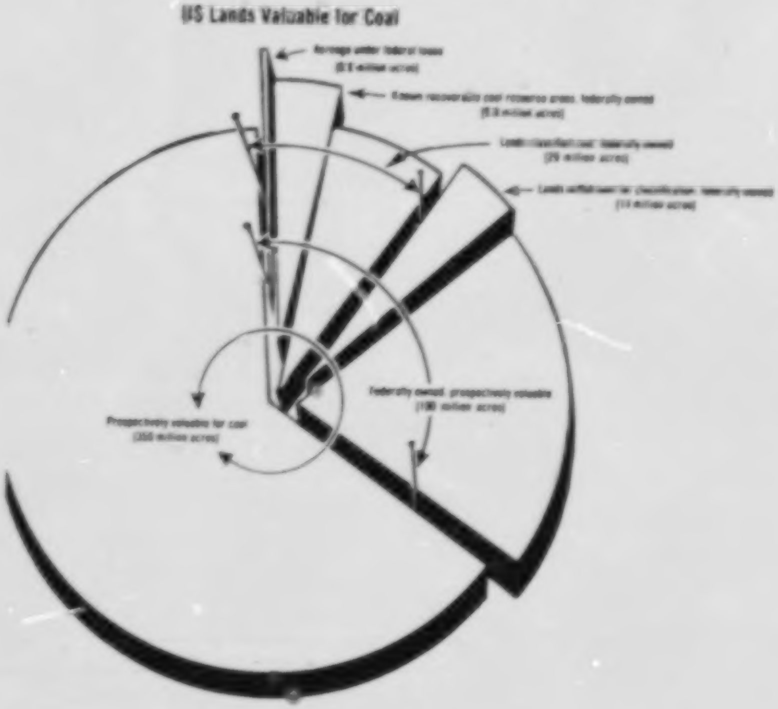


FIGURE 4.—Federal coal: only 0.8 percent of the federal acreage is under lease.

productive coal mines for economic reasons, and some will never become productive because of various environmental and regulatory reasons of fairly recent vintage. For instance:

There has been a radical change from the presumed conditions for development by leaseholders prior to 1970 and the conditions prevailing after passage of the 1976 mineral leasing act for coal. These new conditions or legal provisions will eventually cause some leaseholders to relinquish their lease without mining, particularly if leaseholders are unable to form a logical mining unit and market their coal within the legally required period. The recently published Surface Management of Federal Coal Resource Regulation [2] and Coal Mining Operation Regulations [3] will take their toll on outstanding leases, particularly in view of the newly imposed strict-diligence regulations.[4] In addition, there are the EMARS regulations,[5] which would apply to any future competitive leases.

Why has all this happened?

A major reason for the nonleasing of federal coal during the past six years has been the reliance on reserve-tonnage estimates to decide whether or not to lease coal. "Why should the federal government lease more coal when 16 billion tons of reserve are already under lease application, and an additional 9 billion under preference-right leases? This was, and still, is the argument most frequently ventilated in political and environmental circles. If taken at face value, particularly by people who don't know much else, this reserve-under-lease argument carries the built-in conclusion: "Let's put a halt on coal leasing because the 25 billion tons already leased should be more than sufficient to satisfy all reserve requirements for the present 50 million t/y [tons/year] federal coal production, and projected 150 to 200 million t/y by 1985."

The error in the reserve-under-lease argument—as any experienced geologist, mining engineer, or mineral economist can easily point out—is that such an argument would be valid if the geology, economics and legalities were completely known and understood. In the real world, unfortunately, the reserve-under-lease approach is limited by insufficient geological knowledge, as well as by traditionally misleading interpretations of just what reserves are and what they mean as far as providing a land position sufficient for coal production.[6]

The distinction between poorly known mineral resources and well-known reserves available for production is frequently the most confused and troublesome area in resource management.

The two diagrams in Fig. 5 show recent attempts to clarify these concepts: At the upper left of the diagrams are measured economic reserves, and at the lower right are subeconomic undiscovered resources. Production must come from the upper left sector of our resource base, as shown by the flow of arrows. It is a gross mistake to assume (a) that speculative submarginal resources can reach productive capacity without being moved both to the left and upward in these diagrams, and (b) that reserves can move to productive capacity if legal blocks occur.

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[6] "Reserve is the portion of the identified resource from which a useable mineral and energy commodity can be economically and legally extracted at the time of determination." USGS Bulletin 1450A.

[2] Title 43 Code of Federal Regulations, part 3041, abbreviated (43 CFR 3041).

[3] 30 CFR 211.

[4] 43 CFR 3250.

[5] 43 CFR 3525, Federal Register, Vol. 42, No. 16, Jan. 25, 1977, p. 4453.

The rate at which this movement transforms reserves into "past production" depends both on the current productive capacity and the current demand level. If new high-grade deposits are not large enough to fill the gap, the price rises, and some "subeconomic" deposits move upward into reserves. This shift can also occur when new technology reduces cost—or if legal prohibitions are removed.

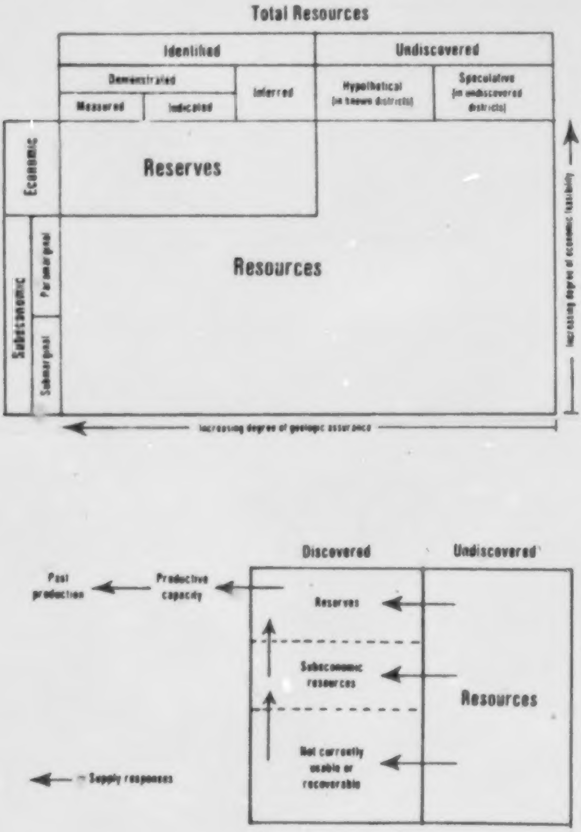
Total Resources
Identified
Undiscovered
Demonstrated
Measured
Indicated
Inferred
Hypothetical (in known districts)
Speculative (in undiscovered districts)
Economic
Subeconomic
Paramarginal
Submarginal
Reserves
Resources
Increasing degree of economic feasibility
Increasing degree of geologic assurance
Discovered
Undiscovered
Past production
Productive capacity
Reserves
Subeconomic resources
Not currently usable or recoverable
Resources
= Supply responses

FIGURE 5.—How "resources" become reserves.

These concepts have never been applied to explain the 16 billion tons of coal under existing lease and the additional 9 billion tons under preference-right lease application; nor were these concepts incorporated into the analysis that yielded those billion-ton figures. The result: reserve-under-lease figures are a potpourri of measured, indicated, inferred, economic and subeconomic reserves and resource estimates—not all of which were economically and legally extractable even in 1973 when these figures were determined. Furthermore, the 16-billion-ton figure fails to include the fact that 30, 40, or more tons of measured recoverable coal are needed to produce just one ton annually, all of which must be in a logical mining unit. During the years of the coal leasing moratorium, many leases that had been applied for to complete logical mining units for new production had not yet been issued.

Any operator must receive timely governmental permission to economically mine coal from measured economic reserves in a logical mining unit, with a large enough reserve position to justify the initial capital expense of property, plant, and development. These factors were not considered either in totalling the 16, 25, or more billion tons of coal under lease.

Even if those bloated tonnage figures were realistic, industry would not and could not be interested in thin beds or poor quality; or in areas with high production costs; or in areas that lack a market; or in areas where federal, state, and local governments have placed so many restrictions—e.g., land withdrawals, restrictive land-use stipulations, complex and time-consuming permit requirements, prohibitive access, arbitrary anti-pollution regulations—that often raise costs on leased lands too high to justify the investment (a prime example: the Kaiparowits leases).

In our opinion, the acreage under lease—compared to total federal acreage potentially known to have value for coal production—would be a more realistic way of measuring the effectiveness of the federal coal leasing program than the undefined estimates of leased reserve tonnage, which may or may not ever be developed. Since monopolies are effectively prevented through a variety of existing mechanisms, since strict diligence is now required along with fair market value for new leases, and since environmental values are now protected in land-use plans, what difference does it make how much tonnage is under lease? What we think is more important is that enough acreage be placed under lease so that coal prices won't be held artificially high by unavailability of land.

HOW WE GOT INTO THIS MESS

Land classification is a prerequisite of minerals leasing. The agency responsible for land classification is the US Geological Survey; the agency responsible for leasing, the Bureau of Land Management (which, before 1946 used to be known as the General Land Office).

Problems of coordination between these two agencies began almost a century ago.

In 1879, the National Academy of Sciences submitted to Congress a report that recommended abolishing the Geological and Geographical Survey of the Territories, and the Geographical and Geological Survey of the Rocky Mountain Region (both in the Department of the Interior), and the Geographical Surveys west of the 100th Meridian in the Department of War. These activities were to be consolidated into a single organization, to be known as the US Geological Survey because, in the words of the National Academy:

"The best interest of the public domain require, for the purposes of intelligent administration, a thorough knowledge of its geologic structure, natural resources, and products. The domain embraces a vast mineral wealth in its soils, metals, salines, stones, clays, etc. To meet the requirements of existing law in the disposition of the agricultural, mineral, pastoral, timber, desert, and swamp lands, a thorough investigation and classification of the acreage of the public domain is imperatively demanded." [6]

Agreeing with the National Academy of Sciences, Congress in the Act of March 3, 1879,[7] provided that the newly formed Geological Survey would be responsible for "the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain."

The same act provided for a commission to codify the land laws.[8] This commission, however, did not merely classify the land laws; it also suggested that land classifications done by the US Geological Survey were "subject to correction upon proof of error satisfactory to the Commissioner of the General Land Office, and according to regulations to be prescribed by him."

In effect, contrary to congressional intent, the commission subordinated the USGS to the General Land Office—by vesting the reviewing responsibility in the General Land Office.

The very first director of the US Geological Survey, Clarence King, accepted the viewpoint of this commission establishing a tradition that continues today in spite of the enormously increased responsibilities of the USGS Conservation Division. In his first report to the Secretary of the Interior in 1880, Clarence King stated:

"I have therefore concluded that the intention of Congress was to begin a rigid scientific classification of the lands of the national domain, *not for the purposes of aiding the machinery of the General Land Office by furnishing a basis of sale*, but for the general information of the people of the country. . . ." This statement, made in 1880, illustrates how land classification became divorced from supporting mineral leasing. Since then, these two functions have never been fully coordinated for their original purpose of "intelligent administration."

King's interpretation prevailed in part until about 1906 when the pressing need of the Department of the Interior for adequate classification of mineral lands led to renewed emphasis on this function of the Geological Survey. This was not done by superseding the machinery of the General Land Office, but by cooperation between the General Land Office and the Geological Survey, augmented by a series of orders from the Secretary of the Interior. These orders defined the part that each was to bear in public land administration, making the Geological Survey chiefly responsible for the classification of lands for their mineral character.

After passage of the Mineral Leasing Act in 1920, the General Land Office (now the Bureau of Land Management) needed mineral and geological engineering expertise to administer its new mineral leasing responsibilities. It's interesting to note that this task of lease support was assigned to a new technical group in the US Bureau of Mines rather than to the US Geological Survey.

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[6] USGS Bulletin No. 537, 11 (1913).
[7] 43 USC 31 (1964).
[8] US statutes at large, Vol. 20, p. 392.

In 1921, the then Secretary of the Interior, Albert Fall, using questionable authority secretly leased without competitive bidding some military oil reserves in California and Wyoming (Teapot Dome) to E. L. Doheny and Henry Sinclair.

Secretary Fall, who went as far as to call the Marines to evict Sinclair's rival claimants from the Teapot Dome reserves, was also found guilty of a corrupt conspiracy to secure for Doheny unleased land in the California reserves and accepting $100,000 in bribes.[9] This touched off a scandal rivaled only by Watergate.

The net effect of the Teapot Dome affair was the quick move of the newly created USBM group (later to be known as the Conservation Division of USGS) to the Department of Commerce. But the administrative incompatibility of the lease support function shared by two federal departments precipitated in 1925 the return of the now Conservation Division to the Department of Interior's Geological Survey.

By separating the leasing agency (BLM) from the regulation-evaluation agency (Conservation Division of USGS), Interior felt it could avoid another scandal and that a potentially cumbersome bureaucracy would be a small price to pay for the separation of power.

Public attitudes and distrust developed in the wake of the Teapot Dome scandal are still felt today and partly explain the present lack of perspective.

Still relying on the authority of the Organic Act of the Geological Survey, the USGS Director continued to be charged with the "classification of the public lands, and examination of the geological structure, mineral resources and products of the national domain." This responsibility was assigned to the USGS Conservation Division and remains today, although modified by subsequent statutes.

In October 1968, Order 2948 by Interior Secretary Rogers C. B. Morton again established certain areas of responsibility for the USGS Conservation Division and the Bureau of Land Management. The order, drafted initially by USGS, was designed to reduce the apparent overlap in responsibilities which had developed over the years. The USGS was given the charter to provide all geologic, economic, and engineering information to the BLM required to fulfill BLM's role in land use planning, environmental analysis, and, in general, minerals management. Strengthened in this order was the Conservation Division's role in classifying lands for mineral content. As a result, BLM formally began requesting of Conservation Division, mineral reports and leasable mineral maps on federal mineral estate.

Classification: A Long Overlooked Tool

The purpose of classifying the mineral character of land (federal and nonfederal) is to define the area and depth limits of each of the leasable minerals. This, in turn, allows for a scientific estimate of the extent of each mineral resource. Classification (as opposed to evaluation) of the leasable mineral anticipates the eventual arrival of conditions favorable for the development and marketing of the commodity. Classification is not concerned with economic conditions that make feasible the exploitation of the deposit at the present time.

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[9] Teapot Dome, History of Public Land Law Development, Public Land Law Review Commission 1968, p. 746.

The first step in the classification procedure has been the withdrawal of the lands containing a leasable mineral from entry, exchange, or sale by using authority granted in the Picket Act (1910).

Next, classification standards are established for each leasable mineral. Since only the ultimate use of the material is important, these standards set minimum limits on the intrinsic factors of thickness, quality, area, and maximum limits on depth.

Both informal and formal classifications are made for various leasable minerals. The informal classifications are made where the available geologic data (often obtained via prospecting permits) is present in such quantity and quality as to meet classification standards, but there is not enough information for a formal classification.

Formal classification orders are published in the *Federal Register.* In effect, lands are classified on the basis of what is known. Initially, lands are classified "prospectively valuable" or valuable in the foreseeable future to perhaps 100 or more years. When sufficient knowledge exists, these land classifications are upgraded to a "valuable" mineral area. For example, a "prospectively valuable" coal area becomes a "classified" coal area. Coal lands are, therefore, "classified" for coal or "prospectively valuable" for coal. As more mineral data is made available, lands are classified valuable for the mineral, prospectively valuable for the mineral, or declassified entirely. Classifications for the other leasable minerals follow this pattern.

Evaluation of Leasable Minerals

In addition to classification, when a leasable mineral resource is determined to be workable under existing economics and technology, it is evaluated as a "Known Leasing Area." Being a workable, economic mineral resource, this category of land includes only those resources known by the government to be most attractive for develment. A Known Leasing Area usually encompasses smaller parts of lands (classified for retention by the federal government) that may eventually be of value. Lands evaluated as Known Leasing Areas theoretically have present-day value. This is why only competitive leasing is permitted for mineral resources within Known Leasing Areas.

The evaluative responsibilities of the Conservation Division stem from the Mineral Leasing Act of 1920 and subsequent leasing acts. The purpose of mineral land evaluation is to obtain geologic data necessary for planning and estimating economic mineral reserves for federal leasing programs.

Those areas that traditionally were shown to have known workability or extent were evaluated as Known Leasing Areas and leased competitively. Unknown areas were leased through the issuance of prospecting permits leading to preference-right leases. New commercial quantity regulations[10] have broadened this traditional function from "workability" (based on intrinsic geologic properties of the mineral resource) to the inclusion of social, environmental, and economic data. However, the mass of information available on intrinsic geology of leasable minerals remains a most useful tool for lease management.

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[10] Interior adopted final regulations pertaining to preference right leasing and the definition of commercial quantities in Jan. 1976. (43 CFR 3520).

The Federal Coal Leasing Amendments Act of 1975 makes all federal coal available only by competitive leasing. However, coal land still must be evaluated as Known Recoverable Coal Resource Areas to establish the existence of minable reserves under existing economic conditions and current technology. The new act also provides for nongovernment exploration under exploration licenses.[11] These licenses yield no preference right to a lease.

The evaluation of Known Leasing Areas should be considered as an additional tool to be added to the classification group designated as valuable and prospectively valuable.

Presently, evaluative activities are adapted to a variety of lease-management support roles. These include: special purpose lease mapping, reservoir and reserve studies, production rate determinations, drainage determinations for oil and gas and geothermal wells, development plans, unitization contracts, requests for abandonment, and many others. All these activities have been directed in the past toward assuring fair market value to the US government and toward eliminating waste of natural resources by inefficient operations. The potential role of using them as an overview tool for leasing policies has never been fully explored. Instead, analysis of "reserves" under lease has been the analytical tool for justifying lease issuance—with well-known results.

WHERE DO WE GO FROM HERE

In the 1879 statute that established the Geological Survey, Congress intended that classification of mineral lands provide an overview of what mineral wealth was contained in the nation's land. Later, the mineral leasing legislation required that comparisons be made between those mineral-resource classifications and these resources economically minable to determine whether a competitive lease or a prospecting permit should be issued. This, in turn, was meant to be contrasted with the nation's long-term needs.

The same overlooked function can be used today to provide a much needed perspective. Briefly, the working concept involves measuring how much of the available resource is being actively tied up for production and comparing that to what we know of the extent of the known resource, less certain environmental constraints.

In Fig. 6, we indicate how the existing knowledge of various mineral resources can be applied in determining minerals management policy. On the far left is an adaptation of the basic Geological Survey classification of mineral resources.[12] Both the economic column (economic feasibility) and the resource column (geologic assurance) are intended to establish relative levels of development potential under present technology and economic conditions. The base of the columns show economically recoverable deposits of measured reserves, or those deposits where tonnage can be accurately computed allowing 20 percent variation. These deposits should be minable under present economic conditions. Continuing up the column, progressively less is known of the actual characteristics and economics of the resource.

The next groupings to the right shows a generalization of existing knowledge of mineral resources either evaluated or classified by the

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[11] Regulations published by Interior describing procedure concerning exploration licenses for Federal coal (43 CFR 3507).

[12] Legal Study of the Non Fuel Mineral Resources, Public Land Law Review Commission, Vol. 1-111, May 1969.

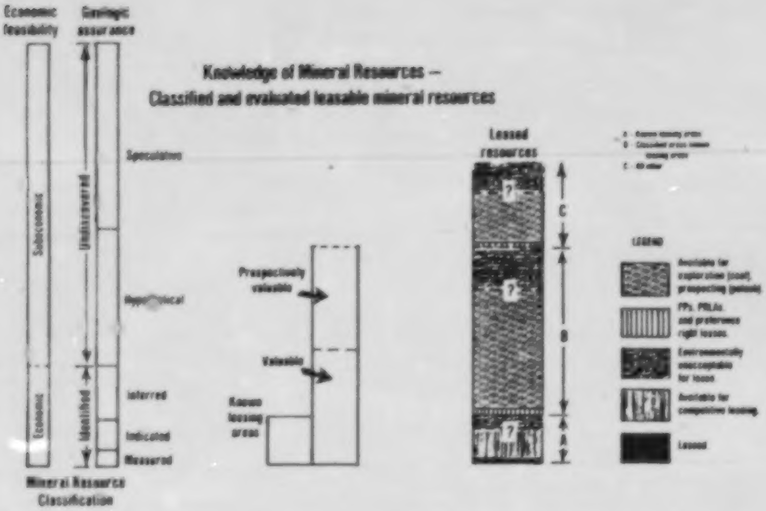
Economic feasibility
Geologic assurance
Knowledge of Mineral Resources –
Classified and evaluated leasable mineral resources
Subeconomic
Economic
Undiscovered
Identified
Speculative
Hypothetical
Inferred
Indicated
Measured
Mineral Resource Classification
Prospectively valuable
Valuable
Known leasing areas
Leased resources
?
C
B
A
A - Known leasing areas
B - Classified areas less leasing areas
C - All other
LEGEND
Available for exploration (coal), prospecting (potash)
PPs, PRLAs and preference right leases
Environmentally unacceptable for lease
Available for competitive leasing
Leased

FIGURE 6.—Classification as a policy tool: issuance of mineral leases under existing statute.

Conservation Division of the Geological Survey. As more information is made available to the government through exploration licenses, prospecting permits, or other drilling information, new land not shown in these columns may be classified, or evaluated as a known leasing area (if presently known to be economic). The difference between the "prospectively valuable" classification and "valuable" classification is merely a function of existing knowledge. As more prospectively valuable land is drilled, its classification is either upgraded to valuable, or known leasing area, or declassified. There must be initial geologic evidence, however, to warrant the prospectively valuable classification in the first place. Although, much of the same geologic data is used in evaluation and classifiction, the best known and economic reserves should be found in the Known Leasing Areas.

The final column on the far right of Fig. 6 illustrates the amount of known resources leased. This amount has been divided into three categories: A, B, and C.

"A" corresponds to the acreage in Known Leasing Areas; "B" corresponds to lands classified less the Known Leasing Area; "C" to all others.

Each category can be further subdivided into lands already leased; lands unacceptable for lease because of land-use plans or environmental analysis or both; and unleased areas available for lease. By existing law, leasing is competitive in "A" (coal, for instance, is entirely under competitive leasing), but noncompetitive in "B." As category "A" is leased, additional prospecting should be encouraged to add reserves from "B" and "C." Since "A" is a measure of the known commercial or workable deposits, the policies that should be followed would obviously depend on how much or how little "A" is under lease.

The perspective provided by land classification and evaluation becomes the foundation of our proposed overview tool for policy analysis. To encourage maximum social and economic benefit from federal mineral resources, here is how the overview tool might function:

Category "A".—Competitive leases should be encouraged in the available unleased areas. If large amounts of "A" remain unleased envorinmental trade-offs within the land-use planning process may become more permissive. In Sedimentary basins where some mining methods prevent simultaneous recovery of several minerals, the commodity with the least available unleased "A" should take precedence in leasing. The total amount leased is determined only by the free market interest. This assumes that government obtains fair market value for resources leased, requires diligence in development, and ensures the protection of environmental values through multiple land-use planning systems.

Category B.—Prospecting permits leading to preference right leases (except for coal) should be issued in available areas, without serious environmental conflict, as a means of learning more about the mineral resource. If an excess of known resources is available and unleased, preference right leasing could be selective, concentrating in areas where information is needed. If an excess of available "A" does not exist: (1) Prospecting permits and preference right leasing should be actively encouraged to increase geologic information in "B" and "C"; (2) Diligence in existing leases in "A" should be reexamined and perhaps strengthened; (3) Environmental trade-offs in "A" then "B" should be reviewed; (4) Research should be encouraged to produce substitute technologies in alternate lower-grade mineral resources.

Category C.—Prospecting permits leading to preference right leases should be selectively issued (except for coal) to add acres to "B" and, eventually, to "A." If nearly all available "B" and "A" are under lease, provisions should be made for: (1) increasing the incentives for research into exploration, available substitutes, and alternate mining technologies; (2) encouraging exploration and investigating tax incentives; (3) reexamining environmental tradeoffs in "A" and "B"; (4) examining policies of strategic reserves in the ground, stockpiling, and increasing prices to encourage substitution; and (5) ensuring that large available mineral reserves are not being held for speculation through the adoption of diligence policies on existing leases.

We think that this tool for mineral-lease management can be developed quickly and easily because a great deal of geologic information already exists for leasable minerals; this body of knowledge will make unnecessary any new large-scale government exploration programs to identify resources already known to exist.

The main advantage of this tool to lease management is that the supply or rate of leasing will be determined by free market forces—such as industry interest and, therefore, commodity demand—constrained only by what is already under lease, and what regulations and procedures are ultimately adopted by the federal government to single out lands environmentally unacceptable for leasing and development.

Certain conditions, however, must be met to insure the success of such a managed leasing program:

Diligence in the development of existing leases must be fulfilled. Diligence requirements may take the form of regulations similar to those under coal (required production by a date certain and exhaustion of minable reserves within a reasonable period of time), or may simply take the form of increased holding costs on a per-acre basis.

Accurate statistics will have to be compiled to determine precisely the extent of federal ownership of classified lands, and the amount of classified land that is not available because of withdrawals, restrictions or land-use and environmental conflicts. (Although detailed ownership data exist for the federal mineral estate, such data have not been applied to classified lands, which include nonfederal mineral estate.)

The Bureau of Land Managament and the Forest Service will have to document lands unsuitable for mineral development because of conflicting resource values, and will have to keep cumulative statistics.

Environmental values will be protected through various agency land-use planning systems, reasonable lease stipulations and a cooperative spirit between the lessor (government) and lessee (industry).

Water problems will have to be considered prior to approval of mining plans.

The tool will only be applied to easily found, classified resources; other widespread resources (for example, metalliferous black shales) may eventually be classified and added to this management tool.

Exploration by the private sector through the issuance of prospecting permits leading to preference right lease outside areas classified as Known Leasing Areas would be encouraged in areas of unknown mineral values where environmental degradation can be minimized (except coal areas). The information obtained will incerase the currency and quality of classifications.

Finally, since no one can effectively classify or evaluate those deposits that are by nature geologically obscured, the "hard to find" minerals (i.e., most presently locatable minerals) will have to remain under a location-patent or simple noncompetitive lease system.

What the New Perspective Suggests

Using the proposed overview tool, we can show at a glance (see Figs. 7 and 8) the present status of federal leasing for coal, potash, phosphate and sodium.

As evident from the comparison of coal and potash (Fig. 7), less than 10 percent of the known recoverable coal resources are under lease—but roughly 70 percent of the known potash areas have already been leased.* As indicated earlier in Table 2, federal coal leases supplied only 7.2 percent of domestic coal production in 1975—but federally leased potash supplied nearly 88 percent of domestic supply in 1975. Since nearly all the known recoverable resources of potash have been leased, our overview analysis indicates that—if domestic potash is to remain plentiful—more exploration and research should be encouraged now; that the Conservation Division should conduct additional classification and evaluation work; that the Bureau of Land Management should issue some additional potash prospecting permits to support this effort, thereby increasing the knowledge of economically recoverable potash reserve; and that potash leasing should take precedence over other leasable minerals where simultaneous mining of several minerals is not possible.

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*Leased land is usually all federally owned. Other categories contain some nonfederal, although prospectively valuable categories in Figs. 7 and 8 have been reduced to estimate approximate federal ownership. These ownership estimates were based on the percentage of federal surface ownership by state. The acreage estimates are likely to be quite conservative since they do not include the 255 000 km² (63 million acres) of federal mineral estate and partial mineral ownership retained by the Government as a result of these classifications.

Unfortunately, the conclusions derived from the overview tool in this instance cannot be implemented because of the low priority assigned to potash and classification compared to other more esoteric programs performed by USGS.

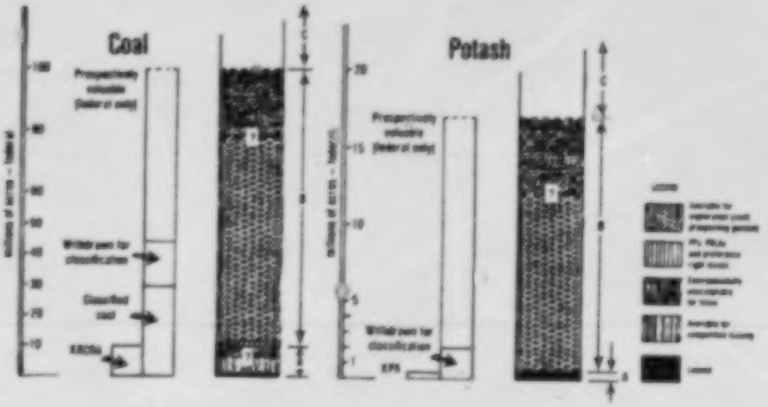

FIGURE 7.—Perspective applied to coal and potash.

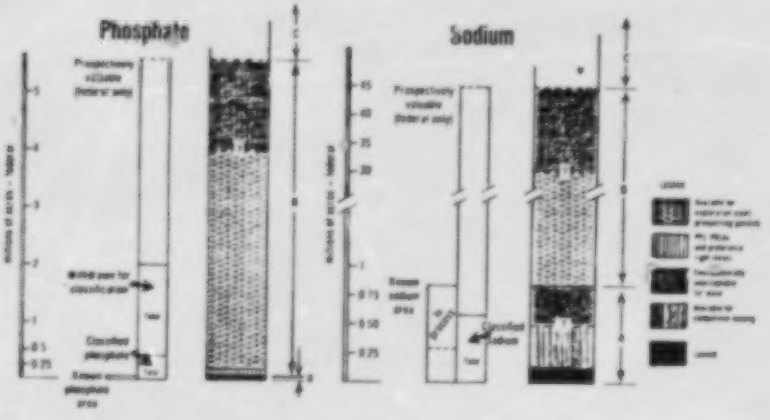

FIGURE 8.—Perspective applied to phosphate and sodium.

Without competent mineral land classification, prospecting permits themselves become unfairly branded as "give-aways." To make matters worse, few competitive leases on lands known to be valuable for a leasable resource have been issued. Impediments include formal land restrictions, informal or "de facto" restrictions through federal land-use planning systems, speculation fueled by nonavailability, and time delays through frequently cumbersome environmental impact statements. This leaves potential procedures no choice but to apply for prospecting permits on whatever land is available although that land may have poor potential for development and relatively high environmental costs.

Cases illustrating this problem can be seen in Wyoming near Rock Springs for sodium, in southeastern New Mexico for potash, and in southeastern Idaho for phosphate. More land has been leased for phosphate than has been evaluated. Even coal requires additional effort. Coal lands in areas nominated for competitive leasing in New Mexico's San Juan Basin, in north central Alabama, in east central Montana, in North Park Colorado, and in other areas have not been fully classified and evaluated. Of the more than 12,500 km² (3.1 million acres) of lands nominated by industry and eligible for federal coal leasing, over 7,300 km² (1.8 million acres), or 58 percent, have not been evaluated by the USGS. In onshore Alaska, lands withdrawn under section 16 and 17(d)(1) of the Alaska Native Claims Settlement Act can only be reopened to leasing once they have been classified by both the BLM and the Geological Survey. Negligible effort is presently being made toward this workload involving millions of acres.

Why?

Table 4 offers some insight into this problem: low priority and not enough funding of Conservation Division activities within the US Geological Survey.

For the entire onshore classification and evaluation of mineral lands, USGS devoted only $4.4 million in 1976—which is slightly more than 1 percent of its $364 million 1976 budget. Yet, the tasks of classification and evaluation are the very responsibilities for which USGS was established.

No proper perspective in federal lease management is possible if the responsible agency itself does not give sufficient priority to these tasks.

TABLE 4.—FUNDING FOR USGS CLASSIFICATION[1]

[In millions]

	Budget for fiscal year 1975	Budget for fiscal year 1976
U.S. Geological Survey	$308.8	$364.0
Conservation Division	36.0	41.7
Classification and evaluation (total onshore)[2]	3.9	4.4
Oil and gas	.17	.32
Coal	2.38	2.53
Oil shale	.30	.30
Geothermal	.96	.99
Nonenergy	.08	.23
OCS oil and gas tract selection and resource evaluation (total offshore)	13.1	14.6

[1] USGS Annual Report, 1976 (in preparation).

[2] Approximately $500,000 is allocated for onshore mineral land classification. The breakdown for onshore classifications and evaluation is shown for each mineral; water power classifications have been deleted.

Conclusion

A new perspective is desperately needed if long-term material needs of the country are to be met. This missing perspective can be recaptured by applying a new tool where what is known of a mineral resource is compared to what is available for lease and to what has already been leased—thereby providing for long-term management of leasable mineral resources under federal control.

Generally, leasable minerals have been subordinated in management priority to both USGS research, surface resources of federal landholding agencies, and other nonmineral development-oriented programs.

Known leasable resources economically minable today should be readily available in environmentally acceptable areas to the free market, by timely competitive leasing. This is not presently the case. To develop new minable reserves from vaguely known reserves, prospecting permits could have a valid future as a means of aiding in classification, particularly where available reserves in known leasing areas are fully leased. Prospecting permits, with coal licenses, can avoid costly inefficient government programs for resources outside known leasing areas where minerals are of negligible present worth. Continued use of prospecting permits can only be justified under existing laws if classification and evaluation programs of the Conservation Division of the Geological Survey receive sufficient priority to maintain public confidence.

There is enough knowledge available to maximize the development of mineral resources by the free market and to plan for future mineral needs by using existing leasing programs as a management tool. No such tool is now in use. Furthermore, long-range policies for federal research programs could be integrated with what is already known of the nation's resources, allowing for timely substitutions by new technologies developed through research. This could eliminate shortages, prior to depletion, and allow for a continuous supply of leasable mineral resources, constrained only by the success of new technology and the price of the commodity—not bureaucratic red tape.

E. Diversification and Private Industry Control of Alternative Sources of Energy

(From Petroleum Industry Involvement in Alternative Sources of Energy, p. 5-11)*

HOLDING OF NONPETROLEUM ENERGY RESERVES BY OIL COMPANIES

It is important to recognize that there can be a considerable distinction between the amounts of a resource that is formally held by a company through ownership, leases, and other arrangements, and the amount of that resource that it actually controls. Control can be achieved through a variety of contractual or stockholding arrangements or because of checkerboard ownership patterns which enable resource owners to control larger areas (logical mining units) than their actual ownership would confer. Thus, a company might control more, or it might control less, reserves than it actually holds. The data presented here represent situations as reported in the literature that is cited as the source, without further analysis or interpretation. . . .

The reserve estimates of the four energy resources included in the report are subject to several limitations. A limitation common to all of the minerals is the lack of comprehensive exploration information from which more accurate estimates can be made by geologists and mining engineers. This shortage of information has led to liberal estimates made through geological extrapolation. In some cases, the lack of sufficient drill core samples has caused scientists to use different methodologies to estimate remaining coal reserves. In the case of West Virginia, wide variations in the reserve estimates resulted. Two studies within the last 10 years estimated West Virginia reserves to be approximately 60 billion tons, but another estimate placed reserves at 39 billion tons. Furthermore, reserves on private lands cannot be determined without the permission of the landowner, which may be withheld in order to avoid attaching a taxable value to the mineral.

The limitation of determining actual resources of minerals such as uranium, were described by Dr. Vincent McKelvey, Director of the U.S. Geological Survey, in the following remarks to the American Ceramic Society on April 25, 1977:

> . . . Most of the readily apparent, easily identifiable deposits that could be discovered by visual inspection have long since been found. What remains are the concealed deposits with no surface manifestations or perhaps at best with only subtle clues to their presence, so that only the most imaginative kind of detective work can elicit clues to their possible existence. Here the frontier is not geographical but intellectual, and can best be described as the capacity for devising new ways of looking at old problems.

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*A Report prepared by the Congressional Research Service and printed for the use of the Senate Committee on Energy and Natural Resources, September 1977.

This view is supported by many in the minerals industry who feel that the day of the "bonanza" discoveries by independent prospectors has given way to the extremely sophisticated technology for geochemistry and geophysics now used to locate and evaluate mineral ore bodies.

In both cases, a systematic approach is essential. For instance, exploratory drilling for uranium must be conducted in an orderly manner or the deposit may escape detection. In the case of geothermal energy, the potential for development has not been able to be completely determined because of the high degree of financial risk involved in drilling for geothermal steam deposits and the current policy of prohibiting utilities from writing off intangible drilling costs. These factors have made companies reluctant to begin exploratory programs, so that relatively few exploratory holes are being drilled. The higher cost of geothermal energy compared to other forms of fossil fuels for electric generation has also discouraged exploration, and consequently the extent of information about geothermal reserves is limited. And while the approximate location and extent of the high quality oil shales in the West have been largely determined, the U.S. Geological Survey has only recently launched an extensive program to determine the location and extent of lower-grade Eastern shales.

In order to adequately determine the extent of all of America's energy resources, the Federal Government may find it necessary either to undertake to directly determine the size of these reserves, or to provide incentives for private industry to commit capital and manpower to the task under some sort of mandatory reporting procedure. However, the institution of such a procedure could have a considerable effect on the resources industry, and on the Government's relationship with that industry, and therefore might not prove attractive.

The problem of determining who holds these energy resources is equally serious. Data on Federal leases is scattered through several agencies, and is not always in a form that can be used for this type of study. Sometimes, the data on resource holdings are only able to be released by the Government in aggregated form in order to protect confidentiality. Many of the figures reported here have only been obtainable through the American Petroleum Institute, and were compiled from data obtained from oil companies on a voluntary basis and may not be uniform.

COAL

The total estimated identified reserves of coal located less than 3,000 feet below the surface of the Earth in the United States is 1,580,987 million short tons. By rule of thumb, approximately 50 percent of this is physically able to be extracted, and of that amount about 60 percent is believed to be in seams that can be mined economically at present market prices. As a result of these approximations, the "total reserve base" of the United States is generally stated to be about 437,000 million short tons. Of this amount, it appears that 51,521 million short tons, or 11.8 percent of the total reserve base, is held by those oil companies which are among the 20 largest corporate holders of coal reserves in the United States. The addition of the coal reserves held by other oil companies would increase this number, for it would seem that at least 5 oil companies holding coal reserves are not among the "top 20" coal reserve holders. (Those companies included among the top 20 holders of coal reserves are Continental Oil. Champlin Oil, Exxon, Occidental Petroleum, Kerr-McGee, Gulf Oil, Mobil Oil, and Sun Oil.)

GEOTHERMAL SOURCES

The potential for production of energy from geothermal sources is not well determined, due in part to the rudimentary state of the technology for tapping this resource and in part to a lack of knowledge of the location, extent, and thermal capacities of these resources. In addition, new geographic locations are beginning to be located.

Oil companies are definitely active in this field, in which their drilling technology has immediate application, and they have been the principal recipients of Federal leaseholds on geothermal sources.

A number of difficult legal and regulatory questions seem to be inhibiting more rapid development of geothermal resources. Some of these involve environmental impacts and leasing regulations. One very important question is whether the steam or hot water from a geothermal resource can be treated as a depletable resource for tax purposes. It would seem that these need to be resolved before a great deal of commercial interest can develop.

The Energy Research and Development Administration is maintaining an active program to solve the technological problems in this area and to demonstrate how different types of geothermal sources can be used. Much of this research and development is being conducted jointly with industry. However, it must be recognized that useful geothermal sources are only known to exist in certain localized areas of the country, and that many geothermal sources will not provide a temperature high enough for steam generation of electrical power. Though these lower temperatures may be useful for local heating applications, the general utility of such sources would appear to be limited.

Under the considerable uncertainty that now exists about the extent and utility of geothermal sources, it is hard to assess whether the oil companies have achieved a position in geothermal energy that will be significant in the future. For the present, the oil companies would seem to be the predominant performers in geothermal energy in terms of development activities and land holdings.

OIL SHALE

Oil bearing shale is found in a number of locations in a broad belt stretching across much of the United States, but by far the richest oil concentrations are found in the western Green River Formation. These are said to contain the equivalent of more than 2 trillion barrels of crude oil. The highest grade shales in this formation can yield more than 25 gallons of oil per ton of rock, and comprise a resource equivalent to about 600 billion barrels of crude oil.

About 80 percent of the shale oil in the Green River Formation lies beneath publicly owned lands administered by the Federal Government. The potential is great, but oil from shale is only beginning to be regarded as economically attractive for extensive development by industry. In spite of Federal efforts to promote development of industrial production through various leasing arrangements of oil shale deposits, all four of the developmental efforts recently underway are currently in abeyance. Uncertainty in the cost of production is not the only factor involved in this suspension. Difficulties in mining and problems relating to air quality regulations are also involved. The adequacy of water supplies, and their possible contamination, may also be a factor, though there have been recent announcements of processes for extracting oil from shale that do not require water. Quite apart from these matters, in the long run there must be a clearer policy for the leasing of Government-held deposits, and agreement on the stringency of environmental standards to be met, so that industry can calculate production capabilities and costs.

The oil companies hold substantial amounts of oil-bearing shale deposits, primarily under State leases and fee holdings. Though it was not possible to locate complete information on the extent of oil company holdings, the data which are available indicate that the petroleum industry has a predominant position among all types of industries in terms of the extent of oil shale holdings. However, these deposits are expressed simply in terms of acres of land held, as a result of the lack of detailed knowledge of the extent and richness of the underlying shale. Thus it is currently not possible to estimate what fraction of oil shale resources are held by the oil companies. Presumably their combined holdings are not large compared with those of the Federal Government. The continuing interest of the oil companies in eventually producing shale oil is attested by the fact that oil companies outbid all other competitors for the four Federal leaseholds awarded in 1974—the only major leasehold awards in 44 years. Thus, oil companies would seem to be the only types of firms now gaining experience in all facets of the mining and restorting of oil shale.

URANIUM MINING AND MILLING

The oil companies have a very strong position in uranium mining and milling. In aggregate, they hold 47 percent of those uranium reserves now estimated to be available at prices of $30 per pound or less. Kerr-McGee is the largest single holder of these reserves, with 21 percent of the Nation's total. The next largest holder of uranium reserves is Gulf Oil, with 11.6 percent of the total. A recent report of the American Petroleum Institute indicates that oil company uranium reserves holdings are almost exclusively limited to deposits capable of producing U_3O_8 at prices below $15–$20 per pound. Of these lower priced reserves, oil companies are said to hold 71.8 percent of the total domestic amounts, with Kerr-McGee holding almost 33 percent of the total and Gulf Oil holding about 18 percent. However, it must be pointed out that substantial undiscovered deposits of uranium may exist, and that many of the sites showing the greatest promise for the discovery of new deposits are on land controlled by the Federal Government. In addition, deposits of uranium ore of lower quality than the $30 per pound category are already known to exist, and might come to be used if commercial prices become sufficiently high.

The oil companies are also active in uranium milling, the initial process of producing uranium oxide (U_3O_8) from the ore. Of the Nation's total capacity for uranium milling, the oil companies own 41.3 percent, with Kerr-McGee alone holding 24.6 percent of the national capacity. In terms of actual production of uranium oxide, the oil companies have until recently shown fairly steady annual increases in their combined share of the total national output. In 1973 the oil companies milled about 38 percent of the total output, though their total output dropped to 30 percent in 1975.

Both the uranium mining and uranium milling industries are fairly concentrated. The two largest holders, Kerr-McGee and Gulf Oil, hold a combined total of almost 33 percent of all known uranium reserves. The top four firms, of which three are oil companies, hold a total of about 42 percent of the known reserves. In contrast to the situation for oil shale reserves, very little of the land definitely known to have uranium reserve is now under Federal control in consequence (1) of numerous Federal land grants to railroads, to States, to Indian tribes, educational institutions, and the like; and (2) extensive claims under the General Mining Act of 1872.[1]

Similarly, the top 5 firms in terms of uranium milling capacity comprise about 68 percent of the Nation's total production capacity. Kerr-McGee and Exxon are among these, with the former firm commanding almost 25 percent of the total U.S. capacity.

In summary, the oil companies have achieved a strong position in uranium mining and milling, with Kerr-McGee exhibiting strength in both areas of activity.

B. NONPETROLEUM RESEARCH AND DEVELOPMENT BY OIL COMPANIES

The oil companies are said to be very active in research at all levels, from the most basic to the most applied, in areas where they sense a commercial potential. This is evidenced in varying degrees by scientific publications, by patents, and by contracts with the Federal Government for the design and development of production processes to produce fuels from coal, as well as by information volunteered by the companies themselves.

Insofar as this study was able to determine, the more basic projects in science and engineering—those having the greatest potential for generating patentable ideas—are generally funded internally and are conducted on a somewhat confidential basis. There seems to have been rather little public discussion about the overall research programs of each company, and the few references that were located for this study provided little insight about the overall research objectives and R. & D. budgets of the various oil companies. However, a recent study sponsored by the American Petroleum Institute has reported figures for the combined expenditures of 23 oil companies in several of the alternative energy fields. In 1975 the total R. & D. investment of these 23 companies was $122 million, of which $29 million supported shale oil research, $51 million supported coal research, and $0.891 million supported geothermal research. Research support involving uranium was not reported explicitly, but was presumably part of $14.5 million reported under "other research."

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[1] U.S. Congress. Senate Committee on Interior and Insular Affairs. Report to the Federal Trade Commission on Federal Energy Land Policy; Efficiency, Revenue and Competition. The National Fuels and Energy Policy Study, Serial No. 94-28, 1976. U.S. Government Printing Office, Washington, pp. 655–656.

Two separate approaches were used to examine the extent of Federal support being provided to the oil companies for research and development on nonpetroleum energy sources. The first consisted of a hand tabulated review of all ERDA contracts in existence. The second, and somewhat broader, approach consisted of a computer search of all grants and contracts made by Federal agencies to the oil companies, using the Energy Research, Development, and Demonstration Inventory maintained at Oak Ridge National Laboratory. These two approaches produced information which seemed to be consistent with reports that the major Federal support of the oil companies is for work that might be described as the engineering design and testing of processes to produce fuels from coal. Many of the projects in this category are fairly large undertakings which often extend over several years in duration. A hand tabulation of the internally financed research reported to the Oak Ridge Inventory of Research, Development and Demonstration provided a list of projects of similar nature. It would therefore appear that in this genre of R. & D., where activity might seem to be focused more toward the ultimate commercialization of a known process than toward the development of totally new processes for the production of a fuel, oil companies are interested in outside financial support and in cooperative arrangements with the Government. The lack of Federal contracts involving more basic stages of research would seem to be consistent with reports that oil companies would prefer to finance such projects internally, though other explanations would also seem possible.

From the standpoint of promoting more efficient planning by the Federal Government to meet the energy problem, it might appear attractive to have greater knowledge of the R. & D. activities and investments within the oil companies. Alternatively there would seem to be strong arguments in favor of maintaining the competition that now seems to exist between the oil companies in their R. & D. efforts, and strong proprietary positions would therefore seem essential. The potential rewards of being able to develop a strong commercial position, either through patents or through proprietary technical capability, in almost any of the new energy areas can be very substantial, so that any company efforts which exist to maintain secrecy would be understandable. Furthermore, the Government must also recognize that it is itself a competitor in the race to develop alternative energy sources. If a federally sponsored program makes an important advance or discovery, the Government may seek to exercise options to insure that the resulting inventions are generally accessible to industry, presumably under some sort of licensing arrangement. This may be a significant stimulus to the oil companies to maintain strong research programs and to increase their research budgets when promising opportunities appear. Thus it may not be true that greater information about oil company research and development would necessarily produce significant benefits in the pace of development of alternative energy sources. Nor is it necessarily true that private investment in energy R. & D. would be increased by changing patent laws to allow federally supported researchers to retain autonomous authority over the use of their inventions.

With so little information available, it is not possible to assess the current or potential contributions of petroleum industry research to the Nation's R. & D. effort. On the one hand, a good argument can be made favoring the incentives of private profit and the advantages of an uncoordinated heterogeneity of scientific approaches as the most rapid and productive way to develop technologies for the commercialization of nonpetroleum energy resources. On the other hand, it is possible that a good deal of the industrial research may be duplicative; that it may overemphasize targets that are not the most important from a national standpoint; and that the success of any company in creating a strong patent position in respect to one of these nonpetroleum resources could create an unacceptable market structure. These sorts of questions would seem to merit serious consideration.

DOES EXXON HAVE A FUTURE?

(By James Flanigan)*

Given two major trends, one geological and the other political and social, the mighty Exxon Corp. could be forced into at least partial liquidation within a decade—not by government edict as has been recently proposed, but out of sheer frustration. It probably won't happen. But it could.

Unless the presently unexpected occurs, the world's petroleum reserves are within a few years of their peak and will begin a slow decline to the point where oil and gas will be too valuable to use as energy. Of the oil that is left, an increasing amount—as in the North Sea—is being taken by government oil companies. This fact alone means that Exxon's future is in question.

Faced with such a situation, most corporations would choose to diversify, perhaps to conglomerate. But who would Exxon acquire that would make much difference to its future? Atlantic Richfield acquired Anaconda, but in its *best* year Anaconda would only have contributed 20 or 30 cents a share to *Exxon's* earnings. Short of acquiring something as big as Procter & Gamble, Exxon would be hard put to make a worthwhile acquisition—and Procter & Gamble is not for sale. U.S. Steel? Would Exxon want it? And if it did, would the Justice Department sit still?

Exxon itself would prefer a different way out. It would like to use its huge resources—technological, managerial and financial—to develop other forms of energy. Even its small diversification efforts—grouped in a venture-capital division named Exxon Enterprises Inc.—reflect this attention to energy. Exxon has invested some minimal amounts in fledgling office-products companies, but far more—over $200 million—in areas such as solar energy and nuclear fuel processing. But here, too, there are problems. An alliance between some liberal congressmen and professional bureaucrats seems determined to prevent Exxon from doing in coal and in nuclear and solar energy what it has done in oil.

The question of whether oil companies should be allowed to develop other energy sources, such as coal or uranium, is before the Congress now in two bills. One is proposed by Representative Morris Udall (D–Ariz.), the other by Senator Edward Kennedy (D–Mass.). Udall's bill would prevent companies engaged, say, in coal—as most oil companies are—from bidding on federal oil leases. It is not going anywhere this session, partly because it would practically cripple U.S. efforts to begin exploration of the continental shelf. Teddy Kennedy's bill would prohibit oil companies from purchasing more coal or uranium properties and require them to sell those they have within three years. It, too, is not conceded much chance this session.

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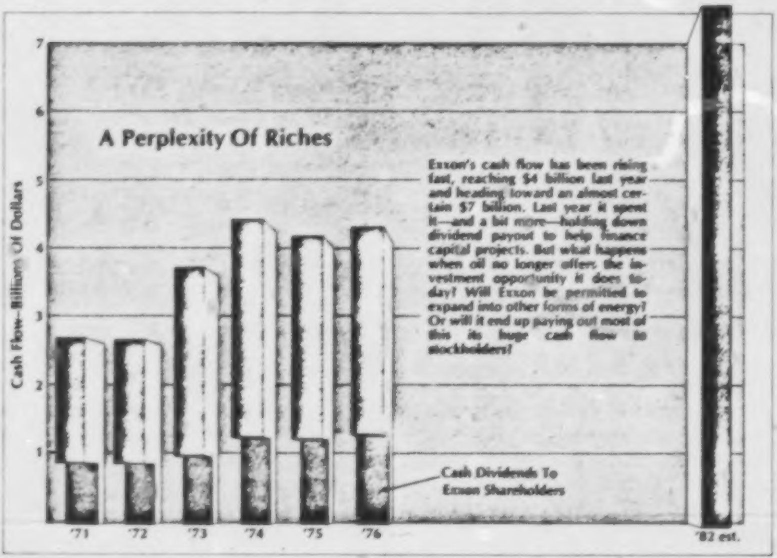
*Reprinted by permission of Forbes magazine from the August 15, 1977 issue, p. 37–41.

The issue won't go away, however, it will come up again and again, as will repeated "investigations," like the one just announced, of oil company pricing and finances. There are many people in Washington who think the oil companies are already too big, too powerful. The effort to break them up seems to have lost its impetus. Therefore, the best way to check their growth and their alleged power seems now to be to keep them out of, or restrict their growth into, other forms of energy.

It is not hard to understand why many people are appalled by the sheer size of Exxon. Exxon is a breathtaking organization. Its revenues this year should hit $55 billion and could be $100 billion by the mid-Eighties. Its earnings last year were $2.6 billion and will be higher this year; its annual cash flow is $4 billion-plus and rising; by the early Eighties cash flow could be $7 billion a year or more. (Last month's mildly disappointing second-quarter earnings report—down 3.4 percent—was a statistical decline due to foreign exchange translations, the company explained; operating earnings were up 11.7 percent.)



A Perplexity Of Riches

Exxon's cash flow has been rising fast, reaching $4 billion last year and heading toward an almost certain $7 billion. Last year it spent it—and a bit more—holding down dividend payout to help finance capital projects. But what happens when oil no longer offers the investment opportunity it does today? Will Exxon be permitted to expand into other forms of energy? Or will it end up paying out most of this its huge cash flow to stockholders?

Cash Flow—Billions Of Dollars
7
6
5
4
3
2
1
'71
'72
'73
'74
'75
'76
'82 est.
Cash Dividends To Exxon Shareholders

Its sales last year of $48.6 billion dwarfed every other U.S. company except General Motors. Exxon's earnings were three times those of Texaco and 2.7 times those of Mobil, to say nothing of more than 2.5 times those of General Electric and Ford Motor. We have big companies in America: U.S. Steel, du Pont, Eastman Kodak. But Exxon's earnings are six times those of U.S. Steel, more than five times those of du Pont and over four times those of Kodak.

Furthermore, because of early appreciation of the way change was coming to the Middle East, Exxon is better situated today than any other oil company. It has huge income-producing properties just opening up in the North Sea and in Alaska's North Slope. By 1980 each of these will be bringing between $400 million and $500 million net income to Exxon. The company's earnings by 1982 will very likely be around $4.4 billion—nearly $10 a share.

Besides this, enormous amounts of money will roll into Exxon in the early years of North Sea production, as much as $10 to $11 cash flow per barrel produced, much of it due to the accelerated depreciation mandated by the British government. Exxon will normalize such a flow for accounting purposes by putting amounts representing British taxes into a deferred-taxes account. But the cash will be there for the spending.

This for a company that is already virtually debt free. Exxon has $3.7 billion of long-term debt; on the other hand, it has $5 billion in cash and marketable securities. The only reason it has taken on debt in the last two years is because government regulations, not financial requirements, warranted it: The Federal Power Commission demanded that the Alaska pipeline be separately financed; the British government, through interest relief grants, encouraged borrowing for some North Sea work. Senior Vice President for Finance Jack F. Bennett foresees no need for outside financing for operations or capital plans in the near future.

This huge pile-up of assets canot be blamed on any reluctance of Exxon to spend money on oil. It plans laying out $4.4 billion a year for capital projects from 1977 through 1981. Opening up new areas in the continental shelf will cost big money, and Exxon is spending $3 billion a year on energy exploration and development. It has invested over $2 billion in Alaska over the last seven years and simultaneously poured $1.4 billion into development in the North Sea. As its current financial position makes clear, Exxon hasn't felt a strain.

But still the money will pile up. Exxon President Howard C. Kauffman recently told Dallas security analysts that the company's problem is not lack of cash, but lack of opportunity.

In the Middle East, where most of the oil is, the producing nations may still need Exxon's technical help, but not its dollars. Mexico is financing its own oil development.

So, unless it can go into other energy areas, coal in particular, Exxon faces a real dilemma. Should it pay out most of its earnings to shareholders rather than invest them? This would be a disguised form of partial liquidation, but if Congress eventually goes along for some kind of "integration" of personal and corporate income taxes (Forbes, *August 1*), the pressure for it could mount.

Exxon knows what it would *prefer* to do with its surplus cash flow. The company through last year had invested some $150 million in coal—not through acquisition, mind you, but through from-the-ground-up development. Since 1967 it has been purchasing coal leases and water rights in the Rocky Mountains and now owns leases on reserves of 8.4 billion tons—making it the fifth-largest holder of U.S. coal. It is opening a mine this year in Wyoming, starting construction on another. It has two mines operating in Illinois and is preparing a fifth mine in West Virginia.

By 1985 Exxon hopes to have nine coal mines operating and to be producing 40 million tons a year of coal, which it will sell to utilities for power generation. But what is that to Exxon? If it earned even $120 million from coal, the business would contribute less than 3%

of Exxon's earnings at that time. Exxon clearly has the ability to put far more into coal. But will it be permitted to?

WHAT FOR AN ENCORE?

Before Alaska began producing this year, Exxon's oil production in the U.S. had been declining 4% a year since 1972. In the early 1980's, while Alaska and the North Sea pump in new earnings, income from the European gas fields, which last year gave Exxon some $420 million of earnings, will be declining.

There is the possibility—even the probability—that the continental shelf holds a great deal of gas and oil. But even this is unlikely to absorb the $7 billion cash flow a year that Exxon will have within five years.

Chairman Clifton Garvin is 55 years old and therefore destined for a long tenure at Exxon's helm. He will guide the company through the beginning of this period of transition in energy—for the company and the U.S.—and he will have to decide what to do with the cash flow. Invest it? Or pay it out?

Garvin, a Portsmouth, Va.-born chemical engineer, is a large, mildly loquacious man. The best word to describe his manner, displayed before an annual meeting of shareholders or up close, is avuncular. He seems unflappable. Listen to Cliff Garvin on what's ahead:

"It's too early in the game to say there are not opportunities, and ample opportunities, to spend a lot of capital money. We've made it clear that going in the coal business is one of our strong desires. It's motivated by several things. One, in the short term, is its use in power generation, but longer-term there is no doubt in my mind we're going to see an awful lot of coal converted into liquids and gas. You don't see that in the Carter message, but it's in the next ten years.

"The way I read that is very practically. It's almost impossible to get any substantial amount of energy through these sources during this next ten-year period. It's the next stage beyond that. But if you look at the costs, the capital costs involved in that kind of conversion, I think it's only going to be a question of how much does a corporation want to invest in that kind of thing. Because I think you could sink as much money as anybody could possibly talk about in going into these synthetics. They just eat up so much capital.

"Also, we have opted to participate pretty strongly in phases of the nuclear business." That's putting it mildly. Exxon has said it is willing to build a plant for enriching uranium, the phase in nuclear energy heretofore reserved for classified government facilities like Oak Ridge, Tenn. For the present, the government is going to keep that franchise. President Carter has announced that the government will build, for $4.5 billion, a new uranium enrichment facility at Portsmouth, Ohio, using a new and less-energy intensive enrichment method called gas centrifuge. Still, Garvin and Exxon persist in the hope that they can get into this very expensive business in the mid-Eighties when another enrichment plant would be needed in the U.S.

The government, comments Garvin, "has left dangling the carrot that down the road these opportunities might be made available to the private sector.

"Now we've indicated our interest in pursuing that. We haven't made the decision because we haven't had to yet. ERDA [Energy Research & Development Administration] has indicated that they want to have a number of entities in the private sector, as government contractors, to build and operate the first stages of centrifuge capacity. We may or may not opt to do that. If we do, it would be in the hope that it would lead us to the opportunities to make investments down the road."

To build a plant for the liquefaction or the gasification of coal would cost $1.5 billion today; a uranium-enrichment plant would cost no less than $4.5 billion. Where other companies would necessarily quail at such amounts, Exxon is fairly itching to spend them.

Exxon sees worldwide growth of nuclear power at 17 percent a year between now and 1990. As Garvin puts it, "The U.S. may be hung up today over whether things like breeder reactors should go ahead. But we're very much of the opinion that in time the world is going to shift and opt and recognize that more and more of its energy generation is going to have to come from nuclear. The gamble we're taking is that there will be a place for the private sector."

Exxon is already in some phases of the nuclear business—as a supplier of fuel cores and as a miner of uranium. Its investment in the business to date is roughly $150 million, about the same amount it has put into coal. For the future it sees its role as being in every phase of the nuclear fuel cycle, with the business centered on the very expensive "refining" or enriching function.

In coal conversion Exxon today is preparing to put up $75 million to ERDA's $120 million (the Electric Power Research Institute and Phillips Petroleum are other partners) to build a $240-million pilot plant for the liquefaction of coal. The pilot plant will turn 250 tons of coal a day into 600 barrels of oil. By 1982 the pilot plant will have been working 2½ years. If it is successful, Exxon plans to follow with a commercial facility for coal liquefaction which would begin operation in 1986. The commercial plant would turn 25,000 tons of coal into 60,000 barrels a day of oil. It would cost $1.5 billion if built today.

In coal gasification, Exxon has developed its own catalytic process and looks forward to signing an agreement with ERDA at the beginning of 1978 for cooperation and funding on a pilot plant. In Exxon's estimation a commercial gas-from-coal plant using its process is possible by 1988.

But given such costs, can the output of such pioneer commercial plants really be called commercial? Not today, certainly, but what might be the cost of imported energy in 1986? If the world oil price merely follows inflation at 5 percent, it will be around $22 per barrel landed in the U.S. at that time.

Exxon is not the only company contemplating coal conversion. The natural gas pipeline companies (Panhandle Eastern, Texas Eastern and El Paso Co.), looking to a supply of future product as U.S. gas deposits dwindle, have large ventures in mind. The trouble is the financing. The cost of such plants could mean borrowings equal to the companies' total equities. Banks are not ready to lend, nor are companies ready to borrow, such life or death amounts for pioneering and risky ventures. Exxon, on the other hand, needn't even ask the bankers. It is financially self-sufficient, or nearly so.

Will the government, will the Congress, let Exxon have a relatively free hand to go where it will?

John O'Leary is administrator of the Federal Energy Administration—the equivalent, as he himself has put it, of Assistant Secretary of Energy in the new Cabinet department. O'Leary has a reputation of understanding the energy industry better than anybody else in the Carter Administration. O'Leary admires the oil companies, calls them nothing less than "the archetypal managers of large enterprises in this age."

O'Leary concedes that the oil companies have technical skills of a high order, as the traditional coal and uranium industries do not. He grants that infusing oil company technical skills into those industries could bring the nation something very useful. Says O'Leary: "I think you have to regard the oil industry as a national asset of no mean value."

But then O'Leary changes tone and wonders whether it is sound policy to allow the oil companies to dominate coal and uranium as they do oil. "We are moving in the direction where we are going to have a single energy system," he says. "The question comes down to: Do you want this whole energy system managed by a relatively small group of people—of which Exxon is a leader?"

To the question of who else could or would do it, O'Leary responds that perhaps purchasers of coal or uranium—the utilities—could put up the financing. This, however, would be like a muzzled dog or tethered horse from the very first—government regulated finance in which an allowable rate of return would be set as often for political as economic reasons. What is wrong with the oil companies doing it? O'Leary brings up his objection: "You have here a subtle point that is not reached by classic antimonopoly law. And that is the attitude and the demonstrated capacity of the oil industry to have its way with the system. The oil industry is probably more competent, with a longer and better track record in the political arena in this country than any other pressure group; maybe the railroads are as good from a historical perspective, but they haven't done as well as the oil companies lately."

O'Leary talks of the oil industry dominating public policy. He talks of the oil lobby the way President Carter, angered at having parts of his energy program changed in congressional committee, lashed out recently at it.

And yet sophisticated observers of Washington know that the power of the oil lobby has declined in recent years, especially since oil became fair game politically after the gasoline shortages and subsequent price rises of early winter 1973. The oil lobby is not nearly so powerful today as it was in the days when Lyndon Johnson of Texas was leader of the Senate, Sam Rayburn of Texas was Speaker of the House, Albert Thomas of Texas was head of the House Appropriations Committee and the most powerful senator bar none was Oklahoma oilman Robert Kerr, cofounder of Kerr-McGee. Those days are long gone.

O'Leary knows—and every politician and bureaucrat knows at heart—that the oil industry cannot seriously challenge the government. The real issue is something else. It is probably no exaggeration to say that politicians and bureaucrats, consciously or unconsciously are jealous of the wealth and proficiency of the oil industry; its independence disturbs them. They would like to annex that proficiency t government; if not annex it, then at least tightly control it. The free market is too messy, too unpredictable for their file-cabinet way of thinking. The solution of many politicians, congressional staff members and government agency officers is to break the oil industry down to smaller units. This, in their way of thinking, would make the business more "responsive" to the people. It would also make the business more easily controllable by the government, whose "responsiveness" the bureaucrats never question.

John O'Leary knows that the issues are more subtle than that, but he feels that through Congress the country should debate and decide whether it wants the big oil companies to control the energy system or should another way be found, using smaller companies. "It seems to me," O'Leary says, "that it offers a very, very fundamental problem of public policy that ought to be looked at by the executive branch and the Congress."

Of course, Exxon and its competitors have been able to achieve the things they have because the free market has given them huge profits—in that sense, consumers have paid for Exxon's progress. But they have also greatly benefitted from them in terms of a wonderfully efficient system. Would it, then, be a bad thing if Exxon were to use surplus profits from oil to develop the coal energy and to help develop nuclear and solar energy? Certainly no other existing industry could so easily and quickly raise the kind of money needed. The government could do so, but the government cannot operate more efficiently than private industry can. It would merely be transferring the burden of development from energy users to all the taxpayers. If the oil companies are prevented from using their surplus cash to develop other forms of energy, this is precisely what must happen.

Listen to Exxon's Clifton Garvin: "If it turns out that we're going to be denied those opportunities to work in the energy field through a combination of government action or what-have-you, then we'd have two basic choices. We could either take the cash flow that's coming in from current successful kinds of investments and give it all back to our shareholders so they may make the choices on what they want to do. Or we could make those decisions that would lead us in other directions, into other fields."

Since the later course—conglomeration—is not a realistic possibility, then it would appear that if the government thwarts Exxon's move into coal and nuclear energy, the company may well go in for what will amount to controlled liquidation.

The ultimate decisions could go in either direction.

On the wall of Federal Trade Commission Chairman Michael Pertschuk's office is a quotation from Adam Smith: "The interest of the provider ought to be attended to only so far as it may be necessary for promoting that of the consumer." Pertschuk, respected in Washington as a smart and practical fellow since his days as chief counsel of the Senate Commerce Committee, has this to say against companies like Exxon: "This economic size means economic and political power. I think that concentrating economic and political power in an entity in our society is antithetical to the democratic tradition."

Sure it is. But how can a democrat (small "d") proffer government—itself swollen and nearly all-powerful—as an antidote to too-big business?

Concentration of economic power *is* a problem, but not just when corporations wield it. If Commissioner Pertschuck wants a motto for his wall instead of a highly idealized portrait of beneficial Government versus malevolent Business; he might settle on something along these lines:

Business profits and government taxes are but two sides of the same coin. Together with savings they comprise the surplus—the sum total of dinners done without—with which the American people satisfy their collective needs. The bulk of profits are, after all, reinvested to provide for our future wants. And government gets the lion's share of our national surplus: Total corporate cash flow—profits after taxes and depreciation—came to $155 billion; total government tax receipts came to $517 billion. Sure, Exxon's cash flow is $4 billion-plus and rising; but the Energy Research & Development Agency's cash flow is $7 billion-plus, and rising. Big government is about three times bigger than big business.

Certainly it is possible to run an economic system with taxes instead of profits. Increasingly, Britain is doing so. The history of a century of regulation of the railroads—a history of enterprise denied, investment opportunities forbidden—proves that we, too, can make the same mistake.

The question before the house is whether Americans want further to narrow the area of private economic decision-making and further to broaden the area of government decision-making. Exxon's future depends on the answer.

IMPLICATIONS OF INVESTMENTS IN THE COAL INDUSTRY BY FIRMS FROM OTHER ENERGY INDUSTRIES

(National Coal Association[*])

I. ISSUE

Should firms engaged in the development or production of one energy source, such as oil or natural gas, be encouraged or discouraged from participating in the development or production of another energy source, such as coal?

II. BACKGROUND

Several bills have been introduced in the 95th Congress to prohibit firms from involvement in the development or production of more than one energy source and require firms already involved with more than one energy source to divest themselves of such involvement.

III. PRINCIPAL ARGUMENT

These legislative proposals have led to sharp disagreement between proponents and opponents of horizontal divestiture.

A. Proponents of divestiture argue

Oil and natural gas company investment in the coal industry would encourage energy monopolies which might lead to:

- holding coal reserves out of production,
- holding down coal production as a means to push up oil or natural gas prices,
- restricting the amount of capital going into the coal industry, and
- restricting investments in coal research and development.

B. Opponents of divestiture argue

The coal industry is and will continue to be a highly competitive industry.

Investments from oil, gas, and other industries have already contributed to increased (1) coal production, (2) productive capacity, (3) private R&D expenditures, and (4) the ability of coal companies to withstand adverse effects of decreased productivity and sales.

Management talent and capital from oil and natural gas firms—and from other industries—are needed to permit expansion of coal production capacity.

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[*] A Report published by the National Coal Association, Washington, D.C., in September 1977. An introductory abstract and some supporting appendices have been omitted here in the interests of brevity. Reprinted by permission.

Existing antitrust laws are adequate to deal with any present or future anti-competitive practices.

There is no serious possibility that a firm or group of firms could obtain a monopoly in coal or even significantly influence the price of coal.

Each of the major points in disagreement—competitiveness of the coal industry, production and reserves, production records of specific firms, capital investment, management talent and adequacy of existing antitrust laws—is analyzed below.

IV. ANALYSIS AND CONCLUSIONS

A. Competitiveness of the Coal Industry

1. *The coal industry is highly competitive.*—The industry is made up of over 3,000 individual firms and is characterized by a low level of concentration in production. No one firm or group of firms, oil or otherwise, is in a position to control the coal industry.

As a general rule, industries where the four top firms control less than 50 percent of production have been regarded as sufficiently competitive to prevent effective collusion.[1] In 1976:

the top 4 coal firms produced approximately 25 percent of output,

the top 8 coal firms produced approximately 34 percent of output, and

the top 20 firms produced nearly 50 percent of output.

2. *The trend in the coal industry is toward reduced rather than greater concentration.*—As illustrated in Table 1 below, concentration reached a peak in 1970 and has been declining since.

TABLE 1.—U.S. BITUMINOUS COAL AND LIGNITE PRODUCTION CONCENTRATION RATIOS, 1960, 1965, 1970, AND 1972–76

Ratio	1960	1965	1970	1972	1973	1974	1975	1976
4 firms	21.4	26.6	30.7	30.2	29.1	26.6	26.1	25.1
8 firms	30.5	36.3	41.2	40.0	39.1	36.7	35.7	34.3
15 firms	39.7	45.6	52.2	50.6	50.5	46.4	45.3	44.6
20 firms	44.5	50.1	56.5	54.9	54.9	51.2	50.0	49.7
100 firms	NA	NA	75.4	78.0	78.9	74.3	74.3	73.9
200 firms	NA	NA	82.6	84.5	86.7	82.1	82.2	81.6

Source: Derived from data in "U.S. Coal Production by Company," 1960–67, Keystone Coal Industry Manual, McGraw-Hill, Inc., New York.

B. Coal production accounted for by coal firms owned by oil and natural gas companies and by other companies with partial oil and natural gas interests

1. *Coal firms owned by oil companies accounted for only 17.5 percent of 1976 coal production.*—As of January 1, 1977, there were nine major operating coal companies owned by oil companies:

Arch Mineral Corporation (Ashland Oil-Hunt Oil);
Ashland Coal Company (Ashland Oil);
Consolidation Coal Company (Continental Oil);

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[1] See for example: Federal Trade Commission Staff Report, *Concentration Levels and Trends in the Energy Sector of the U.S. Economy*, or Bain, Joe S., *Industrial Organization*, 2d ed. (New York: John Wiley & Sons, Inc., 1968).

Hawley Fuel (Belco Petroleum);
Island Creek Coal Company (Occidental Petroleum);
Monterey Coal Company (Carter Oil, subsidiary of Exxon). Monterey is a *de novo* entrant in the coal industry; it was not an operating firm when it was started as a subsidiary of Exxon;
Old Ben Coal Company (Standard of Ohio);
Pittsburg & Midway Coal Mining Company (Gulf Oil); and
Valley Camp Coal Company (Quaker State).

In 1976, these firms produced 17.5 percent of the total U.S. output. In 1976, Sun Oil Company's Cordero mine began production which should be included in any later data compilation. Appendix A shows the details of 1976 production by coal companies affiliated with oil and gas firms.

2. *Even when coal firms controlled or owned by natural gas companies are added to those firms owned by oil companies, the total share of production is only 20.5 percent.*—As of January 1, 1977, five major coal producing firms were owned by natural gas companies:

Zeigler Coal (Houston Natural Gas);
Southern Utah Fuel (Coastal States Energy);
Youghiogheny & Ohio (Panhandle Eastern Pipeline Company);
MAPCO (Mid America Pipeline); and
Eastern Associated Coal Corp. (Eastern Gas & Fuel).

The addition of the 1976 production of these coal companies owned by natural gas companies would bring the 1976 total to 136.5 million tons or 20.5 percent of total U.S. production.

3. *Even if a major coal producing firm which is associated with, but not controlled by, an oil company is added, the total share of coal production associated with oil and gas firms is only 24.0 percent.*—Some analysts have incorrectly included Amax Coal Company as a firm controlled by an oil company. Standard Oil of California owns 20.6 percent of Amax common stock but SoCal and Amax do *not* have a parent-subsidiary relationship. Even if Amax Coal's 1976 production were added, the total of oil and gas firm-associated production would be only 24.0 percent of the total 1976 U.S. coal production.

C. Ownership of Coal Reserves

1. *Ownership of coal reserves is widely distributed and it is unlikely that a firm or group of firms could gain monopolistic control of the coal industry.*—In addition, oil companies do not control a significant portion of total U.S. coal reserves to make it possible for them to prohibit entry into the coal industry and limit competition, as some critics have alleged.

The United States Bureau of Mines (based on U.S. Geological Survey data) estimates that the "demonstrated reserve base" deemed suitable for mining by current methods is 438.3 billion tons. The Bureau of Mines has determined that recoverability varies from 40 to 90 percent depending on the characteristics of the coalbed, mining method, and the legal constraints and restrictions placed upon mining a deposit because of natural and man-made features. Mining experience in the U.S. has indicatd that, on a national basis, at least one-half of all in-place coal can be recovered.[2] Based on this, if the reserve base is discounted by 50 percent, a total recoverable reserve of 219.2 billion tons is available for mining.

Reserve data published in the Keystone Coal Industry Manual, 1977, show that reserves held by oil companies or their coal producing subsidiaries total 46.9 billion tons or 21.4 percent of estimated recoverable reserves. If reserves held by gas companies are included, the total reserves held by oil and gas companies and their coal producing subsidiaries total 55.1 billion tons, 25.1 percent of estimated recoverable reserves. These percentages are over estimated as the data on reserves held by oil and gas companies are not differentiated between recoverable and in-place reserves, whereas the estimates of U.S. reserves have been discounted to a recoverable reserve. Appendix B provides details on reserves held by oil and gas firms in 1976. Other industrial groups also control reserves.

2. *The federal government controls about half of the nation's coal reserves. These reserves are located on public domain lands. Existing laws and regulations prevent any one firm or group of firms from achieving a dominant position in coal reserves.*—The amount of reserves held by the federal government far exceeds the reserves held by oil and gas companies or their coal producing subsidiaries. Because coal is widely distributed, the U.S. Geological Survey has concluded:

> The information available on the distribution of coal and on ownership of coal rights leads convincingly to the conclusion that it would be virtually impossible for an individual, corporation, or cartel to obtain a monopoly on coal or even to significantly influence the price. The reasons for this conclusion are (1) coal is widespread and abundant in the U.S.; (2) ownership is broadly distributed; (3) the federal and state governments own substantially more than half the coal lands and coal rights in the Rocky Mountains and Northern Great Plains regions; (4) leases of Federal coal rights have practical acreage limitations for holdings in any one State;[3] and (5) most major consumers of coal have substantial coal holdings.[4]

3. *The reserves held by coal, oil, natural gas, and other private firms which are in the form of leases of Federal lands are subject to diligent development requirements.*—The Interior Department, which manages a large share of federally owned coal lands, has the authority to establish "diligent development" requirements which regulate the timely development of minerals on federally leased lands. These requirements are designed to discourage holding reserves for speculation. Firms not meeting these requirements are subject to a loss of leasing rights.[5]

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[2] See *Demonstrated Coal Reserve Base of the United States*, (January 1, 1976), Mineral Industries Survey, U.S. Department of the Interior, Bureau of Mines, p. 1, 4.

[3] Recent amendments to the Federal Mineral Leasing Act of 1920 place even greater acreage limitations on leases of Federal lands. Act of Aug. 4, 1976, Public Law 94-377, Sec. 11(b), 90 Stat. 1090, amending 30 U.S.C. Sec. 184 (1920) (codified at 30 U.S.C. 184(a)(1) (1976)).

[4] United States Geological Survey, *Coal Resources of the United States*, (January 1974), p. 89.

[5] 30 U.S.C. 207 (1976).

D. *Production record of coal firms owned by oil or natural gas companies*

Some who believe that oil or natural gas firms have undue control of the coal industry allege that production levels often go down after a coal firm is acquired by an oil or natural gas company. This argument needs detailed evaluation:

1. *An assessment of the production record of a firm must be made in the context of all of the factors that have affected production.*—For the periods involved, several factors deserve special attention:

a. *The principal factor which affects production from year to year is the industry-wide decline in productivity (tons per man per day) that has occurred since 1969, particularly in underground mining.*—This decline in productivity is due principally to changes in mining procedures in order for coal companies to comply with the Coal Mine Health and Safety Act of 1969. Table 2 below shows productivity from 1962 to 1976. As Table 2 clearly shows, productivity declined:

31.7 percent since 1969 in all mines.
45.5 percent since 1969 in underground mines.

TABLE 2.—LABOR PRODUCTIVITY—TONS OF COAL PRODUCED PER MAN PER DAY, 1962-76

Year	Underground	Strip	Auger	Average all mines
1962	11.97	26.76	36.51	14.72
1963	12.78	28.69	38.87	15.83
1964	13.74	29.29	42.63	16.84
1965	14.00	31.98	45.85	17.52
1966	14.64	33.37	44.43	18.52
1967	15.07	35.17	46.88	19.17
1968	15.40	34.24	40.46	19.37
1969	15.61	35.71	39.88	19.90
1970	13.76	35.96	34.26	18.84
1971	12.03	35.69	39.00	18.02
1972	11.91	35.95	43.00	17.74
1973	11.66	36.30	45.33	17.58
1974	11.31	33.16	45.00	17.58
1975	9.54	[1] 26.69	([1])	14.74
1976	[2] 8.50	[1] 26.00	([1])	13.60

[1] Auger included with strip.
[2] Preliminary.

Source: U.S. Bureau of Mines.

b. *Another major factor contributing to lower production is time lost due to strikes.*—In 1971 and 1974, time and production were lost in union mines due to strikes by the United Mine Workers when the contracts expired. In 1971 appproximately 56.4 million tons were lost during the six-week contract strike, and in 1974 approximately 26.1 million tons were lost during the November-December contract strike.[6] In addition, wildcat strikes have been a major and growing problem, particularly in West Virginia. Table 3 below shows the increase in number of man-days lost due to wildcat strikes from 1969 to 1976 and the estimated production lost due to these strikes.

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[6] Source: Bituminous Coal Operators Association.

TABLE 3.—MAN-DAYS AND PRODUCTION LOSSES DUE TO WILDCAT STRIKES, 1969-76

	Man-days lost due to wildcat strikes	Estimated tonnage lost due to wildcat strikes (million tons)
Year:		
1969	626, 500	12. 1
1970	593, 100	11. 4
1971	565, 000	8. 8
1972	515, 600	8. 4
1973	529, 200	7. 0
1974	1, 028, 800	11. 7
1975	1, 417, 400	15. 8
1976	2, 007, 000	19. 8

Source: Bituminous Coal Operators Association.

c. *Another factor contributing to production losses by some companies has been a slack demand for coal primarily caused by:*

Air quality requirements.—particularly state requirements which are more strict than federal guidelines in meeting national health standards—which reduced the demand for coal and encouraged shifts to oil and natural gas as boiler fuel. Federal and state clean air quality requirements have made coal with higher sulfur content from fields in West Kentucky, Illinois, Indiana, and Ohio less attractive for use by utilities and industry.

Lower demand for metallurgical coal.—due to the 1975 economic recession and resultant drop in use of U.S. coal in steel production, both in the U.S. and worldwide.

Artificially low prices for oil and natural gas.—due to Federal price, allocation, and entitlement regulations.

State utility commission actions.—which have had the effect of discouraging investments in new coal facilities and encouraging use of natural gas and imported oil.

2. *In general, coal firms owned by oil and natural gas companies have better production records after acquisition compared to:*

production by the same firms before acquisition,

production throughout the U.S. during the same time period, and

production by independent coal companies in the same general areas during the same time period.

Presumably, the argument that production declines after acquisition would be applicable to these five coal firms owned by oil companies:

Consolidation Coal
Hawley Fuels
Island Creek
Old Ben
Pittsburg & Midway

Arch Mineral Corporation is owned by Ashland Oil Company (48.9 percent) and Hunt Oil Company (48.9 percent). Arch Mineral Co. was formed by Ashland Oil Co. and other individuals in 1969. Ashland Coal Company is just over 2 years old, having been formed through acquisition of five small companies. Both Monterey and Sun are *de novo* entrants.

The argument apparently is also being applied to the Zeigler Coal Company which was acquired by Houston Natural Gas in 1973, Southern Utah Fuel which was acquired by Coastal States in 1973, and MAPCO which acquired its first producing mines in 1971. Youghiogheny and Ohio was acquired by Panhandle in 1976, and Eastern Associated was incorporated in 1963 as a successor to the coal division of Eastern Gas & Fuel Associates.

As one measure, Table 4 below shows each company's average experience in production during the five years preceding and succeeding acquisition.

TABLE 4.—AVERAGE PRODUCTION BY COAL FIRMS 5 YEARS BEFORE AND AFTER ACQUISITION BY AN OIL OR NATURAL GAS COMPANY AND COMPARISON WITH U.S. AND INDEPENDENTS' EXPERIENCE OVER SAME TIME PERIOD

Coal company (parent and acquisition date)	5-yr average output (thousand tons)	Percentage change		
		Company	Independents	United States
Consolidation Coal (Conoco, Sept. 15, 1966:				
Before	43, 850	+35. 0	+11. 6	+16. 6
After	59, 218			
Hawley Fuel (Belco, 1968)[2]:				
Before	1, 702	[3] −6. 0	+4. 7	+10. 3
After	1, 600			
Island Creek [1] (Occidental, Jan. 29, 1968):				
Before	22, 514	+2. 8	+6. 9	+12. 2
After	23, 134			
Old Ben (Sohio, Aug. 30, 1968):				
Before	8, 287	+37. 2	+4. 7	+10. 3
After	11, 372			
Pittsburg & Midway (Gulf, 1963):				
Before	4, 869	+73. 9	+23. 8	+24. 6
After	8, 465			
Zeigler Coal [3] (Houston Natural, 1973):				
Before	4, 169	+5. 8	+5. 2	+10. 2
After	4, 412			
Southern Utah Fuel [4] (Coastal States, 1973):				
Before	223	−238. 1	NA	+10. 2
After	754			
MAPCO [4] (first acquisition, 1971):				
Before	1, 147	+100. 6	+1. 7	+7. 9
After	2, 301			

[1] To prevent a biased comparison, Island Creek's publicly reported output from 1969–73 was reduced by subtracting the production of its Maust coal properties which were acquired in 1969. If these tonnages were included, the 5-yr average production subsequent to acquisition would have been 26,293,000 tons or 16.8 percent above the preacquisition 5-yr period.

[2] Belco sold 80 percent interest in a number of mines (Hawley Coal Mining Corp.) to a French company. In October 1976, the company purchased the remaining 20 percent interest in HCMC. Production levels here reflect the sale of Hawley's ownership in these mines.

[3] 3-yr averages.

[4] 4-yr averages.

Source: "U.S. Coal Production by Company," 1962–73, Keystone Coal Industry Manual, McGraw-Hill, Inc., New York; Minerals Yearbook, 1962–75, and weekly coal reports, U.S. Bureau of Mines, Department of Interior.

3. Where production has not increased, the lower levels can be understood in the context of factors that have affected production.—In all cases except one shown in Table 4, average coal production by oil or gas affiliates—when compared over a 5-year period—has increased after acquisition. However, recent production trends may not show yearly increases, as detailed in the year-by-year comparisons of production for each company owned by an oil or natural gas company, including Monterey (a *de novo* entrant).

As summarized in Table 5 below, the production levels of several companies during the 1974–76 period are only slightly higher and some are lower than production levels during the year of acquisition. Monterey is not included in Table 5 since it is a *de novo* entrant; Valley Camp and Youghiogheny & Ohio are omitted because they were acquired in 1976.

TABLE 5.—COMPARISON OF AVERAGE 1974-76 PRODUCTION WITH PRODUCTION IN YEAR OF ACQUISITION

Company	Year of acquisition	Production year of acquisition (thousand tons)	1974-76 average production	Percent change
Consolidation Coal	1966	51, 400	54, 200	+5. 4
Island Creek	[1] 1968	25, 880	[2] 19, 292	[2] −25. 5
Old Ben	1968	9, 915	9, 469	−4. 5
Pittsburg & Midway	1963	6, 024	7, 582	+25. 9
Hawley Fuel	1968	1, 540	647	−58. 0
MAPCO	1971	1, 124	3, 211	+158. 7
Zeigler Coal Co.	1973	4, 273	4, 412	+3. 3
Coastal States	1973	339	754	+122. 3

[1] Date of acquisition January 1968; 1967 was used as the last full year of independent production.

[2] In 1975 and 1976, Island Creek had approximately 5-6,000,000 tons unused productive capacity. This capacity was idle due to market conditions. The average production 1974-76 is not indicative of Island Creek's coal production capacity

These recent company production trends must be assessed in the context of the factors which have affected production.

The experience of Old Ben Coal Company and the Consolidation Coal Company illustrate the factors that have affected recent production trends.

a. Old Ben Coal Corporation

The Old Ben Coal Corporation merged with Standard Oil (Ohio) in 1968. During the subsequent 5-year period (1969-73), Old Ben's annual production averaged 11.4 million tons per year compared to 8.2 million tons in the 1963-68 period, an increase of 37.2 percent. Old Ben's annual production per employee peaked in 1969, the year the Coal Mine Health and Safety Act was passed, and began a decline to its current level—a 43 percent drop. Also, time lost to UMWA contract and wildcat strikes during the recent period has more than tripled from the previous period. Similar problems have affected all members of the industry which operate unionized deep mines.

Old Ben Coal Corp.

Annual output per employee:	
1969	6,500 tons.
1976	3,680 tons.
Time lost to strikes:	
1965-70	2.2 percent of available mine days.
1971-76	7.3 percent of available mine days.

As a direct result of time lost to strikes, production declined for 2 years in a row before increasing in 1976.

Despite steep declines in deep mine labor productivity, which are believed to be a direct result of specific work rules imposed by the UMWA and the Mining Enforcement and Safety Administration, Old Ben and Sohio have invested heavily to expand coal production capacity. Also, employment has risen 58 percent since the merger.

Average annual capital expenditures

	Million
Premerger (1963-68)	$4. 3
Merger present (1969-76)	15. 8
Planned future (1977-79)	48. 2

Despite these efforts, recent production has remained in the 9–10 million ton range because huge boosts in investment and employment have helped offset declining productivity, increased strike losses, and property depletion. If it were assumed that Old Ben could equal its 1969 high level of output per employee, its production capability today would be over 17 million tons. This estimate is conservative because Old Ben's recent increases in strip mine capacity have masked the deep mine productivity drop on a company-wide basis. In fact, the corporate production goal set at the time of merger was 1975 production of 17.9 million tons and 1976 production of 19.5 million tons.

b. Consolidation Coal Company

Consolidation Coal Company was acquired by Continental Oil Company in 1966. While Consolidation Coal Company's production did increase during the 10 years (1966–76) after the acquisition by Conoco, it was during a period of the greatest loss of productivity in the history of the United States coal industry.

Two-thirds of Consolidation's production is from underground mining. During the 1969–76 period, the industry's underground productivity was cut almost 50 percent from about 15.6 tons per man-day to about 8.5 tons per man-day. Consol's overall experience was the same with productivity dropping from 21.93 to 12.07 tons per man-day during this period. As a result, Consolidation Coal had to increase its employees by nearly 50 percent merely to maintain tonnage. At the end of 1976 it had 21,480 employees compared to 14,527 employees in 1969.

The Federal Coal Mine Health and Safety Act of 1969 has had the greatest impact, resulting in underground mine production losses from 22 percent to 46 percent depending on the mine. The Act, coupled with a dramatic increase in absenteeism, wildcat strikes, and union work practices under new labor contracts, caused these staggering production losses. As a result, Consolidation and other companies with underground mines were forced to more than double their labor costs just to maintain production levels.

For a detailed statistical analysis of the recent production trends of Old Ben Coal Company and Consolidation Coal Company.

E. Comparison of Relative Production Experience of Independent Coal Firms with those Owned by Oil and Natural Gas Companies

As one additional basis for comparing the relative performance of coal firms owned by oil and natural gas companies, Table 6 below compares the 7 firms of primary interest (7 oil company affiliates) with 11 independent companies operating in the same general area—Appalachia, Indiana, Illinois and Western Kentucky—and with total bituminous coal production east of the Mississippi River. Table 6 shows that oil company affiliate performance is at least equal to, if not better than, the experience of the independent coal companies operating in the same area. *This, along with the fact that production levels generally increased immediately after acquisition, demonstrates that factors other than oil company ownership acted to limit recent increases in production.* (NOTE: comparisons are limited to 1969 since it was during this time that production drops were most pronounced. Production experience of gas affiliated companies is not included here because the acquisitions are too recent—1971, 1973, and 1976.)

TABLE 6.—YEAR-TO-YEAR COMPARISON OF PRODUCTION OF OIL AFFILIATES WITH 11 INDEPENDENT COMPANIES AND TOTAL PRODUCTION EAST OF MISSISSIPPI

[Tons in thousands]

Year and change	7 oil company affiliates [1]	11 independent companies [2]	Eastern United States
1969 (tons)	113,017	58,985	527,203
1970 (tons)	115,594	59,513	558,020
Percent change 1969–70	+2.3	+0.9	+5.8
1971 [3] (tons)	98,820	55,960	501,197
Percent change 1970–71	−14.5	−6.0	−10.2
1972 (tons)	119,142	63,242	531,051
Percent change 1971–72	+20.6	+13.0	+6.0
1973 (tons)	116,990	62,290	515,303
Percent change 1972–73	−1.8	−1.5	−3.0
1974 [3] (tons)	104,642	55,941	511,900
Percent change 1973–74	−10.6	−10.2	−0.7
1975 (tons)	105,105	59,990	537,504
Percent change 1974–75	+0.4	+7.3	+5.1
1976 (tons)	109,902	57,777	530,003
Percent change 1975–76	+4.6	−2.7	−1.4

[1] Includes Consolidation Coal, Island Creek, Old Ben, Pittsburgh & Midway, Arch Mineral, Ashland Coal Co., and Hawley.

[2] Includes Pittston, North American, Westmoreland, Rochester & Pittsburgh, Jewell Coal & Coke, Blue Diamond Coal Carbon Fuel, Sovereign Coal, Beckel-Rosman, Sahara, and King Knob.

[3] United Mine Workers contract strike during year.

Source: "U.S. Coal Production, by Company," 1969–76, Keystone Coal Industry Manual, McGraw-Hill, Inc., New York; Minerals Yearbook, 1962–751 and weekly coal reports, U.S. Bureau of Mines, Department of the Interior.

F. Geographical Difference in Factors Affecting Coal Production

The three principal factors affecting production—decline in productivity, strikes, and slack demand—have contributed to the stagnation of the coal industry in the Eastern United States, the area most heavily affected by these three factors and the area where the coal companies acquired by oil and natural gas firms operate.

The *de novo* entrants into the coal industry (with the exception of Monterey) will be less affected by these factors because they are concentrated in the West.

G. New Energy Industry Entrants into Coal Industry

Oil companies which are entering the coal industry through the acquisition or lease of reserves and subsequent development through coal producing subsidiaries include:

Exxon
Texaco
Tenneco
Sunoco
Shell
Kerr-McGee
Mobil
Atlantic Richfield
Phillips

Additionally, El Paso Natural Gas holds reserves and is currently negotiating for contracts which will enable development of these reserves.

Until 1976, the only oil company listed above to actually produce coal was Exxon (through Monterey Coal). In 1976, Sunoco began production at its Cordero mine in Wyoming with an initial production of 10,000 tons. The current status of coal development of the other companies appears to be as follows:

Mobile Oil Corporation.—expects to initiate a construction program within a year for part of its surface mineable lease near Gillette, Wyoming (subject to issuance of state and federal mining permits). Earlier development was impeded first by the *Sierra Club v. Kleppe* suit and then by lengthy environmental clearance procedures.

Tenneco.—holds lignite reserves for possible future activity in coal gasification.

ARCO (Atlantic Richfield).—holds western reserves and, according to the Bureau of Mines report "Projects to Expand Fuel Sources in Western States," is planning production of 9 to 12 million tons per year by 1985. Initial coal production is expected by November 1977. This production was anticipated earlier but was delayed by *Sierra Club v. Kleppe.*

Shell Oil Company.—entered the coal business through acquisition of reserves and plans production by 1980.

Texaco.—holds reserves which may be used for coal gasification. Texaco has developed a gasification technology which has already been demonstrated on equipment which can gasify 12 tons of coal per day. Texaco and three utilities have submitted a proposal for a gasification demonstration plant to be jointly funded by ERDA and private industry.

Kerr-McGee.—is now developing coal mines in Wyoming which are scheduled to begin production in 1979 and 1980.

Phillips.—acquired its reserves through its own exploration and acquisition efforts in heretofore undefined coal areas. Phillips, which holds lignite coal reserves, expects to be in production in the early 1980's.

El Paso Natural Gas.—is negotiating with electric utilities for the sale of coal for generation of electricity and is continuing its efforts to develop a coal gasification complex (currently in abeyance due to capital costs).

H. Capital Investment for Coal Production

1. There is considerable need for additional capital to *expand coal production.* The Federal Energy Administration estimates that, based on coal production in 1985 of 1 to 1.2 billion tons a year, the coal industry will need between $17.7 billion and $22.4 billion to expand coal production to meet projected needs.

2. *Oil and natural gas companies owning coal firms have invested large amounts of money in coal production.*—Data show that oil companies entering the coal business have and are investing large amounts of capital. For example, the five-year total capital expenditure of the [illegible] coal companies for which data were available and which are now [illegible]ed by oil firms was:

$162.4 million before acquisition; and
$556.5 million after acquisition.

This is an increase of almost 243 percent or $394 million.

3. *If proposed horizontal divestiture legislation is enacted into public law, a large new source of capital for the coal industry would dry up and make expansion of production difficult.*—Proponents of horizontal divestiture have not considered the impact of such legislation on providing the capital needed by the coal industry. At a time when the coal industry is expected to nearly double production by 1985, horizontal divestiture would dry up a significant source of capital

infusion for the industry, thereby jeopardizing existing production capacity and making large-scale expansion of production much more difficult.

In order to meet 1985 production goals, the coal industry must commit itself to an aggressive program of capital expenditure. The industry must attract capital from outside sources. One source of outside capital is the oil industry which has a unique expertise in resource extraction, an understanding of resource management, and a willingness to invest in high-risk development. Horizontal divestiture will result in increased costs of attracting external capital to the coal industry and a lower debt capacity. This would probably lead to significant delays in increasing coal production.

I. Management talent for the coal industry

The declining demand for coal in the 1950's and early 1960's left a gap in the infusion of new management talent into the coal industry.—What appeared to be a declining industry during the 1950's and 1960's was not attractive to new management talent and the financial condition of most of the industry did not permit coal companies to embark upon bold new programs. This has resulted in a gap in the management talent bank for the industry which must be filled primarily by attracting people—particularly with knowledge of energy—from other industries. Oil and natural gas industries have been a significant source of new, innovative talent for the coal industry.

J. Adequacy of Existing Antitrust Laws

Existing antitrust laws provide substantial authority for protection against anti-competitive behavior should it occur in the coal industry.—Both the Sherman and Clayton Antitrust Acts, along with the 1976 Hart-Scott-Rodino Amendments, provide the government with ample legal recourse to guarantee the competitive nature of the nation's economy.

K. Conclusion

Firms engaged in development or production of one energy source, such as oil or natural gas, should not be prevented by legislation from participating in the development or production of another energy source, such as coal.

The usual arguments for horizontal divestiture do not stand up under close scrutiny. Outside industry participation in the coal industry has not lessened competition within the industry. In fact, the coal industry is highly competitive in comparison to other industries. As illustrated in Table 1, (p. 3) the trend in the coal industry is toward reduced rather than greater concentration. The concentration of the coal industry reached a peak in 1970 and has been declining ever since. Moreover, ownership of coal reserves is widely distributed and it is unlikely that a firm or group of firms could gain monopolistic control of the coal industry through the domination of reserves.

Outside industry entry into the coal industry has enabled many coal companies to maintain production in the face of declining productivity, has enabled companies to withstand the extreme fluctuations for demand for coal, has enabled the industry to increase expenditures for research and development, and has made capital available for expansion. If a continuation of these and other contributions to the coal industry were prohibited through horizontal divestiture legislation, it is doubtful that the coal industry could retain its ability to expand rapidly enough to meet the national energy goals of the United States.

APPENDIX A

1976 COAL PRODUCTION BY COAL COMPANIES AFFLIATED WITH OIL AND GAS FIRMS[1]

Company	Production (thousand tons)	Percent total United States
Consolidation Coal Co.	55,000	8.4
Arch Mineral-Ashland Coal	[2] 18,000	2.7
Island Creek Coal Co.	17,606	2.6
Old Ben Coal Co.	9,715	1.5
Pittsburg & Midway Coal Co.	7,924	1.2
Monterey Coal Co.	2,700	.4
Hawley Fuel Corp.	769	.1
Subtotal, 8 oil affiliated companies	112,682	16.9
Valley Camp[3]	3,617	.5
Subtotal, 9 oil affiliated companies[4]	116,299	17.5
Eastern Associated Coal Corp.	7,950	1.2
Zeigler Coal Co.	5,176	.8
MAPCO	3,916	.6
Youghiogheny & Ohio Coal Co.	2,082	.3
Southern Utah Fuel Co.	1,043	.2
Total, Oil and gas affiliates[5]	136,475	20.5
Total U.S. production (priminary)	665,000	100.0

[1] "U.S. Coal Production by Company 1976", Keystone Coal Industry Manual, McGraw-Hill, Inc., New York.

[2] As reported by Ashland Oil Co.

[3] Acquired by Quaker State in 1976.

[4] Some analysts include Amax Coal Co. in this total. However, Amax's relationship with an oil firm is not the parent-subsidiary relationship as SoCal owns only 20.6 percent of Amax stock.

[5] Excludes some small companies affiliated with oil and gas interests for which data are not available. It is unlikely that total oil and gas affiliated production is seriously understated because of these exclusions.

APPENDIX B

RESERVES HELD BY OIL AND GAS FIRMS, 1976

Company	Reserves[1] (million tons)	Percent total, United States
Continental Oil (Consolidation)	13,700	6.3
Exxon (Monterey Coal-Carter Mining)	[2] 8,400	3.8
Occidental Petroleum (Island Creek)	[2] 3,574	1.6
Gulf Oil (Pittsburgh & Midway)	[2] 2,750	1.3
Mobile Oil	2,500	1.1
Sun Oil	2,200	1.0
Atlantic Richfield	2,200	1.0
Phillips	2,000	.9
Tenneco	1,700	.8
Texaco	1,650	.8
Kerr-McGee	1,500	.7
Shell Oil	1,460	.7
Sohio (Old Ben)	825	.4
Chevron	700	.3
Ashland Oil (Arch Mineral, Ashland Coal)	650	.3
Belco (Hawley Fuel)	524	.2
Quaker State (Valley Camp)	475	.2
McCulloch	50	
Total, oil companies	[3] 46,050	21.4

See footnote at end of table.

APPENDIX B

RESERVES HELD BY OIL AND GAS FIRMS, 1976—Continued

Company	Reserves[1] (million tons)	Percent total, United States
El Paso Natural Gas	5,200	2.4
Houston Natural Gas (Zeigler Coal)	1,000	.5
Eastern Gas & Fuel (Eastern Assoc. Coal)	1,058	.5
Panhandle Eastern (Youghiogheny & Ohio)	500	.2
MAPCO	450	.2
Coastal States (Southern Utah Fuel)	[2] 35	
Total, oil and gas companies[4]	55,101	25.1
Total, United States	[5] 219,100	100.0

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[1] The data reported for each company are not differentiated between recoverable or in-place reserves.

[2] Data as reported by company named.

[3] Some studies include Amax Coal Co. in this total. However, the relationship of Amax with an oil firm is not a parent-subsidiary relationship, as Standard Oil of California owns only 20.6 percent of Amax stock. If Amax were included in this figure, reserves held by oil firms in 1976 would total 51,896,000,000,000 tons or 23.7 percent of total.

[4] Excludes some reserves held by small oil and gas companies for which data are not available. It is unlikely that total oil and gas reserves are seriously understated by these exclusions.

[5] The "total demonstrated coal reserve base" defined by the U.S. Geological Survey and the Bureau of Mines as that portion of the identified resources deemed suitable for mining by current methods totals 438,300,000,000 tons. The Bureau points out that recoverability varies in a range from 40–90 percent according to the characteristics of the coal bed, the mining method, legal restraints, and the restrictions placed upon mining a deposit because of natural and man-made features. Mining experience in the United States has indicated that, on a national basis, at least one-half of the in-place coal can be recovered. Discounting the coal reserve base by 50 percent gives a total recoverable reserve of 219,200,000,000 tons.

PART THREE

Resolved: That the Federal Government should establish a comprehensive program to significantly reduce energy consumption in the United States

. . . [c]onservation is not simply an issue of waste versus nonwaste; the boundary line between these two extremes is defined both by economics and by tastes and preferences. . . .—*Lee Schlipper and Joel Darmstadter*

. . . [n]o fundamental scientific barriers exist to prevent substantial improvement in energy end-use effectiveness. . . .—*Thomas Widmer and Elias Gyftopoulos*

. . . [w]hen construction and station energy are considered as well, rapid rail ranks among the least energy-efficient of the conventional urban public transportation modes.—*from Urban Transportation and Energy: The Potential Savings of Different Modes*

. . . [t]he principles behind the President's plan . . . call for a reduction in the consumption of petroleum-generated energy . . . even assuming that urban rail transportation is more energy-intensive than highway-vehicle oriented transportation, rail transit can be powered by an energy source that does not use any petroleum. . . .—*Atlantic Metropolitan Rapid Transit Authority*

The portrait [the] experts paint of an energy-efficient society looks to be a far cry from the nontechnological Thoreauvian rusticity that the word "conservation" evokes. . . . Instead, it would be a tightly organized, capital-intensive society whose hallmark would be meticulous engineering.—*Tom Alexander*

Certainly, some social gains could be realised by successful adjustment to a steady-state society. . . . [but] . . . the kind of wisdom and will that is needed to move humanity away from its current obsession with forcing open the secrets of the universe, in a supreme bid for god-like power, just cannot be mustered within the institutions of the modern world.—*E. J. Mishan*

To those who insist that we can no longer tolerate economic growth, my response is simply that we cannot afford to do without it.—*Bayard Rustin*

A. The Economics of Conservation

THE LOGIC OF ENERGY CONSERVATION

(By Lee Schipper and Joel Darmstadter)*

Energy conservation is rapidly replacing the weather as a popular and vexing topic that everybody talks about. Our ability to overcome the misunderstanding on the subject remains in doubt, for energy conservation extends far beyond the mere reduction of energy consumption. In at least some of its dimensions, energy conservation may be more far-reaching and complex than most people imagine. But, properly understood, conservation is good for us.

There are two fundamental ways to save energy: either society can use less energy per unit of any specific good or service it produces; or society can shift toward a less energy-intensive mix of goods and services. Of course, conservation is not the only factor that can prompt this shift; for example, advanced industrial economies tend toward less energy-demanding service industries.

MEASURING ENERGY CONSERVED

One complication in energy conservation is the actual measurement of energy consumption. The best unit we can use to measure energy inputs is the amount of primary resources in the economy (barrels of crude oil or tons of coal) required to produce a given product. Even if energy is conserved at an end-use or intermediary stage between production and consumption, it still should be discussed in terms of primary energy resources saved. For example, although a particular energy conservation measure may save only one unit of electricity, this indicates a savings of over three units of primary energy required to generate the electricity.

As conservation analysts, we also consider the nonenergy resource inputs, such as labor or capital, which frequently are affected by changes in energy use. Output parameters may include such overall values as Gross National Product (GNP) or "industrial value added" in a specific product line; or they may include more specific measures such as passenger-miles travelled or tons of steel produced. Energy conservation measurement thus uses a ratio of energy input per unit of output, such as energy consumed to GNP, or energy consumed per dollar of shipment in a particular industry, or energy use per passenger mile.

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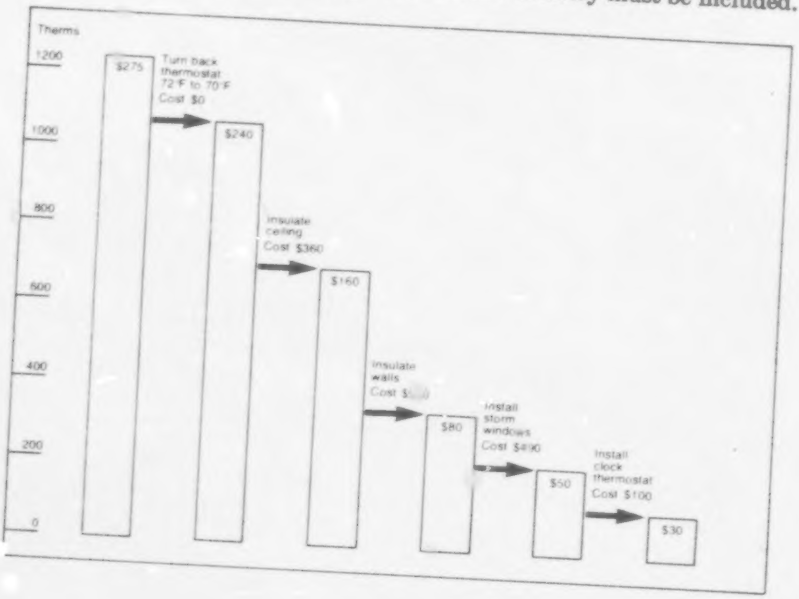
*From Technology Review, Vol. 80, No. 3, January 1978, p. 41–50. Technology Review is edited at the Massachusetts Institute of Technology. Copyright © 1978 by the Alumni Association of M.I.T. Lee Schipper, formerly an Energy Specialist with the Energy and Resources Group at the University of California, Berkeley, is now a researcher at the Lawrence Berkeley Laboratory. Joel Darmstadter is a Fellow with Resources for the Future in Washington, D.C.

In most cases, direct measures of energy intensity suffice when discussing a conservation strategy that will affect techniques of energy use in a product. However, if a conservation technique relies on resources that themselves are energy intensive (such as substituting an electric furnace for a blast furnace in steelmaking, or replacing iron and steel with plastics and aluminum in automobiles), indirect energy requirements should be included. Clearly, any changes in the consumption patterns of non-energy goods and services that alter the economy's energy requirements are complex, and must be considered on both a direct and an indirect energy-use basis. For example, the magazine you are holding represents consumption in many industries upstream from the printing press: this includes the trucking, the paper, and the chemical industries (for ink, chemicals for pulping, and chemicals for papermaking).

WASTE AND ECONOMICS

We must be careful how we measure energy conserved, for many times it is unclear what conserving or wasting really means in human terms. Homemakers insulating their homes at a cost below their fuel bill savings are certainly practicing energy conservation; but if they acquire larger homes in the Southwest or North that require more fuel to cool or heat for a given level of insulation, it is certainly improper to say that energy is being wasted. If, on the other hand, the newer homes require significantly less energy per square meter per degree-day, then we may label these homes "energy conserving." Thus, measuring energy conservation and waste requires more than mere before-and-after quantities of energy used. Knowledge of the intensities of energy use and the type of economic activity must be included.



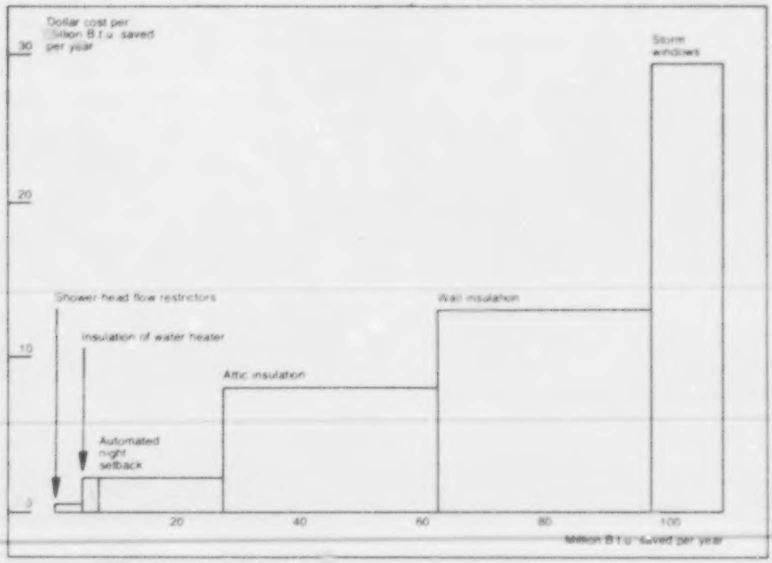
But intensity alone does not measure waste or efficiency. We doubt, for example, that trading a conventional refrigerator for a frost-free model is wasteful! The return for an unchanged level of cooling and the elimination of defrosting *is* higher electricity use, with subsequently higher bills. But such a choice is not an irrational response to a costly temptation to gadgetry. It is a trade-off of energy for time and drudgery. Similarly, substitution of automatic for manual transmissions in autos increases the energy required to operate the vehicle, but saves driver effort. Indeed, these illustrations themselves suggest that overuse or abuse of words like "sacrifice" or "Moral Equivalent of War" may blunt consumer interest in conservation.

Thus, we see that energy use alone is not a sufficient yardstick with which to measure optimality. One person's frivolity may be another's necessity; last year's indulgence, this year's need. While intensity is a physical measure, efficiency is an economic measure that requires measurement of all resource inputs.

In this light, each individual consumer should be allowed to divide up his or her energy needs (and other resource uses) into a spectrum ranging from the absolutely necessary to the absolutely unnecessary, and structure his or her life accordingly. Needs and wants, frivolities and necessities, depend on cost and perceived benefit. Denunciations of one sort of waste or another therefore should be viewed somewhat skeptically.

This leads us to the central principle which, in our opinion, should underlie any conservation policy or discussion: conservation involves changes in resource use or preferences that, in the eyes of the people conserving, maximize well being. Conservation is a means to greater welfare, not an end in itself. The most impelling factor in encouraging conservation action is the cost of not conserving.

Because of the welfare-enhancing characteristics of conservation, we question the curtailment of energy supplies (gasoline rationing, for example) as a conserving technique. Curtailment would be acceptable and appropriate if it were part of a planned emergency policy package, designed to effect rapid reduction in energy demand with minimal social and economic dislocation. Similarly, measures aimed at limiting economic growth in the interest of saving energy affect well being by restricting economic productivity by the misallocation of scarce resources. These measures may be considered appropriate by those who believe a moderation of economic growth to have virtue in its own right; they do not belong within the conservation framework.



Charts above: The annual space-heating costs for an average family living in the San Francisco Bay area could be decreased considerably through retrofitting with insulation, thermostat set-backs, etc. The predicted energy savings are shown in the first figure. Obviously the potential for savings is enormous in places like California, where most homes have little or no insulation. In the second figure, some of the same options are seen with additional estimates on savings from hot water conservation in terms of gas conserved in a 1,400-square-foot uninsulated single-family dwelling. Here the vertical axis shows the investment cost per million B.t.u. saved per year; the horizontal axis gives the energy savings per year, and the area the total investment. If the cost of energy is known, then the straight-line rate of return can be read off as that cost divided by the investment cost of the particular option.

The dilemma for policymakers, of course, lies in the fact that a variety of factors serves to depress energy prices, and thus reduces the rate of return on conservation. Storm windows, which would be attractive in California if natural gas were made from coal (at $4.00 per million B.t.u.) or if only electric resistance heat were available, look like a poor investment for the majority of consumers who pay $2.00 per million B.t.u.—a price pushed downward by controls and other policies. If gas is so abundant as to render low prices appropriate, then we might not be concerned about "conserving" gas. But if, as many suspect, gas is more scarce than its price suggests, then most consumers will overconsume by underconserving and pass up opportunities to save that fuel. (The full documentation of "Two Zone," by Arthur Rosenfeld, et al., is found in Lawrence Berkeley Laboratory Report LBL5271.)

HOW TO CONSERVE ENERGY—AND HOW MUCH?

We have said that conservation, properly viewed, is actually the opposite of sacrifice, given rises in fuel prices or other conditions such as environmental decay. If we accept this attractive definition of conservation—and virtually every careful study of the subject (*see charts above*) points to the economic rewards—then what do we do to conserve?

Substitute other resource inputs for energy (insulation investment to reduce the energy needs for heating, for example);

Change our habits, preferences or operating procedures to reduce energy use (lower thermostats or increase maintenance of industrial boilers);

Change the mix of goods and services to demand less energy (take vacations in less distant spots.

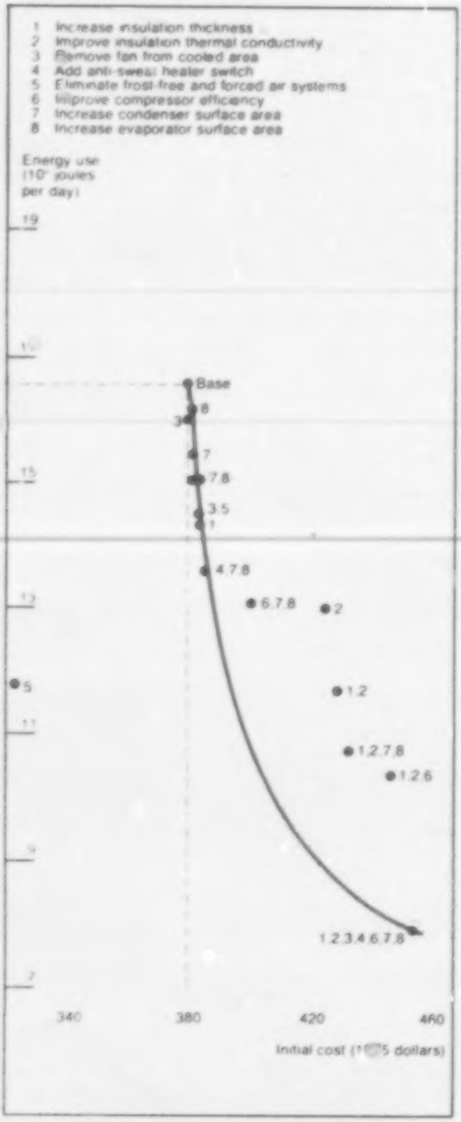
These three responses to concern about energy use should be the primary focus of conservation strategies. In strategies of the first type, studies indicate that in many important applications, most notably processs and space heating, conservation technologies can reduce the energy requirements per unit of activity by 30 to 80 per cent of today's use (*see illustration below*). Behavioral and preference changes might affect where we live, how far we travel, how many appliances we have, and what kinds of indoor environments we prefer, but it is generally acknowledged that innovative technical changes offer far greater savings in energy in the next 30 years.

While the literature (including back issues of *Technology Review*) abounds with technical prescriptions for saving B.t.u.s, economic guidelines about how much to conserve are another matter. We have emphasized that conservation is desirable whenever we can perform energy-related tasks more productively—for a smaller total resource input—taking the totality of costs into account.

Some energy conserving practices, such as lowering the thermostats at night, are essentially costless; that is, they involve no increased outlays for other resources and do not intrude significantly into living standards or behavior. However, many energy conserving options do involve significant substitutions or non-energy resources for energy. So both total resource-cost implications and energy implications must be considered in any conservation decision. For example, a steam-electric power plant produces more electricity per unit of fuel if the steam inlet temperature is increased, but requires in turn more expensive material. Is the fuel saved worth the extra capital cost?

The answer, of course, is to compare the cost of investments that save energy with the benefits of fuel savings. The price of fuel saved is central to this calculation. Indeed, Roger Sant, former Administrator for Conservation at the Federal Energy Administration, suggests that each conservation option be viewed as a source of energy, and that we compare the discounted unit value of energy saved with the cost of purchasing similar or alternative fuels. Since it costs less to produce a B.t.u. this way than to generate or produce one from any new energy source, the greatest motivation for conserving is the cost of not conserving.

Unfortunately, governmental regulatory policies such as oil and natural gas price controls, utility pricing practices, or subsidies to producers—which artificially depress price—keep the consumer from seeing or paying the marginal or replacement cost of producing the next unit of energy. This replacement cost is significantly higher than the prevailing average or historical cost. Consequently, each energy user's incentive to conserve energy falls below the economic optimum,



Improved technology can cut energy use—and the total cost of owning and operating a refrigerator—by conserving energy. An improved refrigerator merits some additional expense because it can cut energy use enormously. Moreover, the rate of return on such an investment, while dependent upon the price of electricity, almost always exceeds 25 per cent per year. In the above chart, daily energy use (or intensity) is plotted against the first cost of a 16 cubic ft. top-freezer refrigerator incorporating the given options. In this case the technologies are all available: some refrigerators incorporate them already. (Haskins and Hirst, Oak Ridge National Laboratory, 1977.)

which is set by the marginal cost. Worse, environmental costs often still are excluded from the balance sheet. Nevertheless, even with these problems, a given set of energy prices allow us to find out how much energy the economically rational user would conserve.

Bear in mind that short-term measures such as add-on investments in insulation and lowered thermostats affect energy use significantly, but by no means do they equal the impact of replacing inefficient equipment in the natural course of economic growth. New investment ushers in the most dramatic drop in energy intensities. Ironically, the faster the economy grows, the larger the opportunity for conservation, if one subscribes to this notion.

The fact that new capital equipment offers the largest and cheapest energy savings per unit of investment bears comment. First, while cars and appliances are discarded within years, structures and manufacturing equipment last for many decades. Those intent on seeing conservation bite deeply thus need to be patient: indeed, the ultimate potential conservation in buildings or industry alone over a 30-year period is greater than the total energy consumption for autos and appliances combined. Moreover, the speed of implementation depends on the economic rewards—the value of energy saved—as well as standards or implementation programs and incentives. But this also means that, while restricting the use of recreation vehicles or gaslights may be politically symbolic, these measures save little energy compared with imaginative technical approaches. For example, mass transit, while worthwhile for many non-energy concerns, may save neither energy in particular nor economic resources in general unless accompanied by regulatory incentives and/or the redesign of cities. Recall that today the tax system subsidizes purchase of single family dwellings in low-density surroundings. This may be good social policy, but it has been fatal to mass transit in many places. The energy "waste" symbolic of existing transportation arrangements and the presumed virtues of mass transit, while often mentioned in connection with conservation, therefore, should not be pushed too strongly by energy conservation advocates unless the broader aspects of those activities are also taken into account.

Evaluating the kind of conservation that substitutes non-energy resources and new technical practices for energy has become the specialty of a growing community of researchers. We think that the value or price of the energy to be saved is central to such an evaluation (see below). Nevertheless, we frequently encounter the notion that demand is not really sensitive to price. Certainly the demand for some amenities—driving, vacations, single family dwellings—may be relatively insensitive to energy prices. But the least costly ways of providing these and other energy-using amenities do depend on energy costs. Thus "how much to conserve" depends on consumer tastes as well as technology and pricing trends and policies.

THE PITFALLS OF AGGREGATE RATIOS

Although there have been numerous studies and much debate over the value of energy/GNP ratios in predicting demand, the aggregate nature of both the numerator and denominator in the ratio warn us to treat this number with extreme caution. Superficially, the ratio is a rough indication of how much energy it takes to sustain a given standard of living, insofar as GNP measures standards of living. The difficulties in evaluating and comparing GNP from a single country over time or among countries are well known. More important, the joint use of GNP and energy totals obscures economic and demographic factors.

For example, energy-use totals generally do not differentiate among particular kinds of energy, each of which have characteristic thermodynamic properties and prices. Also, the influence of climate is seen in the demand for fuel and for space conditioning, but is not reflected directly in the GNP, as is the geography and density of countries and regions. The energy embodied in products that make up the bill of import or export goods should also be kept in mind.

Unfortunately, single ratios relating energy to labor, capital, or output, especially in the aggregate, have become the popular vehicle for spirited but often uninformed analyses, ironically by both those who speak for the energy industry, such as *Energy, the Economy, and Jobs* by Winger and Nielsen of the Energy Group at the Chase Manhattan Bank, and by certain environmentalists, such as Barry Commoner in *The Poverty of Power*. Both these analysts attribute far more meaning to simple ratios than we would accept, given the subtleties of economic and political conditions that guide energy use, efficiency, and conservation.—*L.S., J.D.*

The Swedish experience, which we have studied extensively, reinforces the notion that energy price helps determine the choice of energy-using equipment. Faced with energy costs traditionally 25 to 100 per cent higher than in the U.S., Swedish factories opt for more efficient processes and practices in producing their extensive selection of energy-intensive goods. Swedish autos average 24 m.p.g., and Swedish single family dwellings use less fuel for heating than those of the same size in the U.S., in spite of a tremendous climatic difference.

A CONSERVATION PARADOX

The neglect of socio-economic factors can seriously hinder energy conservation policy. For example, district heating systems have been proclaimed by many as an excellent energy conserver, for they use waste heat from power plants or industrial processes to heat whole communities. But the Swedish experience with these systems has shown that the people using the systems can still waste energy. Apartments in Sweden which are heated by central systems are rarely metered on an individual basis, so there is no individual incentive to control temperature to save money. And the systems are not easily regulated, for usually there are no thermostats that measure indoor air temperature. Heat should be regulated by turning the radiators off or on. However, most Swedes have developed a more precise technique for controlling heat—opening the windows. As a result of these practices, the use of energy for heat in Swedish apartments is nearly as high per square meter as for single-family dwellings, even though in theory heat use should be considerably lower.—*L.S., J.D.*

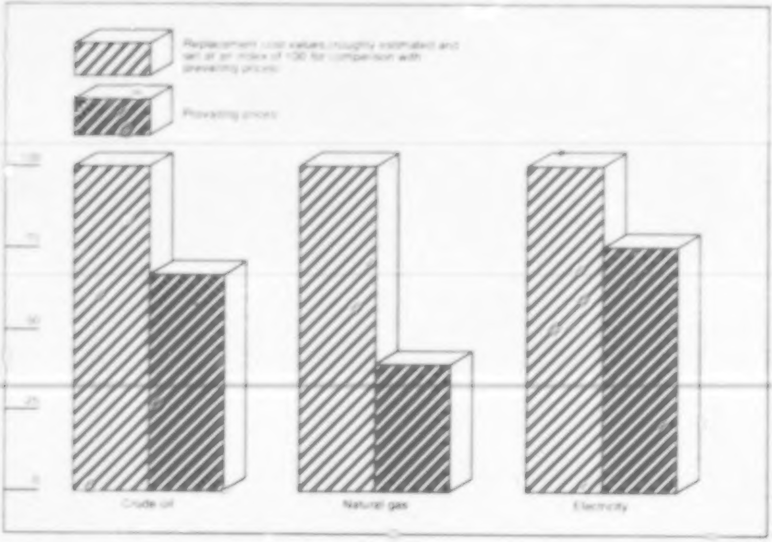
Yet Sweden is by no means an "ideal" energy consumer. This suggests that there is no definable limit to conservation, at least not until we approach both thermodynamic limits and the exhaustion of our ingenuity to modify and refine tasks. Conservation, depending as it does on the evolution of energy costs and technology, is not a one-time option, but rather a continual reevaluation of the mix of resource use that allows us to minimize the total cost of resources used to achieve an end. For this reason, conservation planners should look ahead and avoid taking measures that will foreclose even more beneficial practices in a future where energy prices and other resource costs will change. For example, restricting the area of windows to reduce heat losses would be foolish; that regulation might deprive builders or architects of the option of using large windows as passive solar heat collectors.

There is also the question of how consumers would handle conservation measures that reduce energy use and thus lower cost, but also change their perceived amenity levels. Some resource substitutions that lower the cost of a given amenity might stimulate users to seek greater levels of that amenity, bringing it back up to a previous level. For example, a well-insulated home might spur the homeowner to keep his thermoastat turned up, incurring the same heating costs as the homeowner with a lower thermostat in an uninsulated home.

Conversely, there may be consumers who, rather than blunting the impact of higher energy costs through substitution, are willing to accept less amenable conditions. These people would lower the thermostat rather than insulate. Researchers feel more secure dealing with the substitution case because it is susceptible to unambiguous cost-benefit calculations; but we should not discount the possibility of more elusive behavioral changes interacting with those that are economically deterministic.

Some consumers, given information, encouragement, and the incentive of more costly energy, may adapt their behavior to drive less than otherwise, heat less than otherwise, and use fewer applicances. Others will first investigate all the possible energy-conserving technical possibilities, such as insulation, energy-monitoring devices, and other options for existing or new homes and autos, before they adopt less energy-intensive habits. Predicting these two disparate responses is important to conservation policy research and development. Consumers do not easily relinquish amenities—many of which are energy-intensive activities or products that grew in importance as energy prices declined—related to comfort, convenience, and mobility. But this does not preclude the exploitation of attractive opportunities for technological energy conservation, which may be determined by energy prices and policies. Mobility is not curtailed while energy is conserved if, for example, automobiles are made of light aluminum rather than steel.

However, we must emphasize that only a few non-energy goods and services are energy-intensive (measured in B.t.u. consumed per dollar of final demand). Changes in energy prices will have only a small effect on the prices of most of the consumption decisions involving these activities. Energy is still the tail of the economic dog, and it seems reasonable to assume that other economic or social forces might be felt long before energy costs change the mix of goods and services consumed. Energy, notwithstanding its importance when suddenly unavailable, nevertheless accounts for only about 10 per cent of the total income we spend. Conservation, therefore, must not be oversold for its own sake, unless the value of conserving (whether easily expressed in an engineer's equation or understandable only as a contribution to national security or environmental well being) is made clear. Conservation does not justify expensive fixed-rail mass transit systems, whose energy conserving status is questionable. Energy use per mile is not the only criterion for "efficient" transportation. By the same token, such systems need not always fall back on energy conservation or on conventional profitability guidelines to be "sold"—other characteristics, such as reductions in pollution or congestion, may be of equal value.



Economic efficiency is best served when the price paid reflects what it would cost to replace or product one additional unit of the product in question. In the U.S., energy products continue to be priced on a basis far short of replacement values. As a result, demand has been higher than it might be, and a barrier has been created to investment in conservation.

Nevertheless, we believe that energy will be conserved primarily by technical means, although gradual changes in behavior and lifestyles will help as consumers find themselves as well or better off using less energy. We speak with certainty: the future will be somewhat different than the past. The cost of energy will probably rise toward the end of the century; innovation and common sense will allow us to respond to higher costs by saving that which is dear.

ENERGY AND GNP

When all the different energy uses are added together and compared with changes in the GNP, the two measures seem to be well correlated historically, with GNP growing slightly faster.

In general, the energy required to support a certain GNP is determined by both the make-up of the GNP and the intensity of energy use. Also, countries where (or eras during which) a relatively higher portion of energy is delivered to final demand (as in the U.S.) would tend to have a higher energy-to-GNP ratio than countries with similarly structured intermediate demands but lower demand for comfort heating and personal transportation. Energy delivered directly to final demand "produces" less GNP than the energy combined with other resources to produce the goods and services that make up most of the GNP. Even the relative shares of manufacturing and services need not predetermine the energy/GNP ratio. While it is widely held that services require less energy per unit of GNP than manufacturing, services are coupled to energy use via transportation and heating and cooling of buildings where services are made available. The amount of energy "required" to make a given service available depends on how far the purchaser must travel, and how the building involved is designed and run. Thus we caution that there are few firm rules that apply to understanding the relationship between energy and GNP. Energy and economic activity must be considered separately and in detail before any great conclusions can be drawn about the aggregate "efficiency" of energy use.

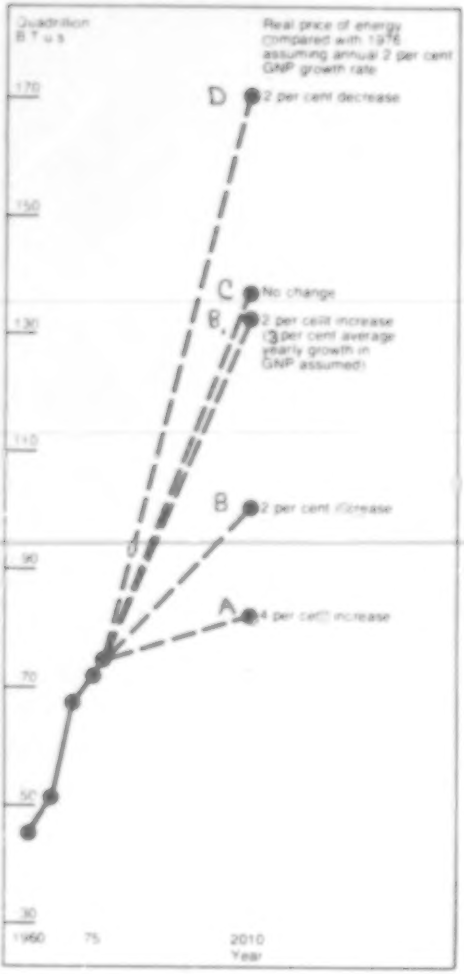
A recurrent theme of this essay has been that energy is but one of many resources that combine to produce goods and services. Simple aggregated ratios, such as energy/GNP or energy/worker, enjoy popularity in discussions of present and future energy needs. These ratios, however, omit two things; explicit consideration of structure, and substitution of resources. Most reliable information about energy use, needs, and conservation comes only from a detailed examination of the uses and factors that influence the uses of energy with other resources.

THE COST OF NOT CONSERVING

If we can overcome the temptation to correlate energy use and GNP, we will find that the future will be different from the past, if only because rising energy prices now make the cost of *not* conserving considerable. It costs more to produce energy today than to save it, at least in many of its uses. This increase in resource cost does mean a small loss in real income relative to lower cost energy, to be sure. But conservation minimizes this loss. The rate of return on most conservation investments often exceeds that of new energy supplies. Thus pushing conservation to the economic optimum stimulates an economy which had hitherto been operating below its capacity.

Looking through the range of forecasts, we find extrapolations that still foresee a near doubling of U.S. energy use and only a small drop in the energy/GNP ratio. Since the ratio has dropped anyway for the last 75 years, such forecasts incorporate little more than a prediction of what might happen if relative energy prices were to continue to fall. But more detailed, disaggregated forecasts seem to find plausible a level of energy "needs" in the year 2000 falling between 90 and 120 Quads (a Quad is 10^{15} B.t.u.) for a 70 to 100 percent increase in real GNP (*see chart below*). Of course, if energy use were inelastic with respect to price (that is, if no substitute resources or technologies existed), then energy use would keep much more in step with the GNP. Fortunately, virtually all evidence suggests that this need not be the case.

How much we "conserve" might be estimated by simply estimating how much energy would be used to supply a given quantity of goods and services in the year 2000 at today's intensities, and reestimating the amount at tomorrow's (conserving) intensities. The difference would



Neither U.S. economic history nor comparisons with other industrial countries point to a unique relationship between a nation's economic growth and its use of energy. One recent attempt to project U.S. energy-economy linkages over the next 30 years finds that, depending on the course of future energy prices and a corresponding pursuit of cost-effective conservation possibilities, a given rate of GNP growth might occur with a wide range of energy growth rates. Of course, one should not be dogmatic in such views, as the future contains many surprises. The hypothetical (and preliminary) forecasts were developed by the Demand/Conservation Panel, Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences. Historical data from Bureau of Mines are plotted at 5-year benchmark intervals. All alternatives assume average yearly GNP growth rates of 2 percent except for variant B_1, at 3 percent. In all cases, assumed GNP rates are higher during early decades, lower toward end. Assumed yearly increases (or decreases) in real energy prices were: A, 4 percent; B and B_1, 2 percent; C, no change; D, minus 2 percent. Trends to 2010 are not assumed to be linear.

be attributable to conservation. Further, the likely mix of activities in the year 2000 will be intrinsically less energy-intensive, largely because we can drive only so much or heat so much space, two activities that in the past slowed the drop in the energy/GNP ratio considerably. All things considered, the amount of energy we conserve will depend on energy prices, technological development, lifestyle, tastes, policies and, of course, the rate of turnover of our capital stock. Again we emphasize that conservation, while unlikely to reduce the absolute amount of energy consumed, will slow the growth in that consumption, easing supply problems but not eliminating them all together.

Policymakers need a clear understanding of the effects of energy prices on a consumer's motivation to conserve. As we have said, prices may affect a homeowner's choice to insulate or to simply lower the thermostat. We should be wary of projections of future energy "needs" based only on historical data—or projections that ignore experience—if they do not reflect the future possibilities and motivations, both economic and otherwise, toward conservation.

Similarly, we must exercise caution when using highly aggregated statistics to project energy needs. The demand for goods and services produced with energy may decrease if energy costs rise. Estimating the energy impacts of any group of decisions will be extremely difficult because of the complexity of energy requirements of various mixes of activities. Even the often cited trend from manufacturing-oriented to service-oriented industries can, as we have indicated, be misread. Supposedly a service-oriented society would be energy conserving, but services include home upkeep, hotel stays, and gasoline, while manufactured goods include fishing gear, handheld calculators, and citizen's band radios, all with energy intensities considerably below the national average. Thus, we need to know which goods and which services the future will bring before prognostication about energy can be reliable.

CONFUSION IN WASHINGTON

Measuring energy conservation confused the Carter administration. In February, 1977, both Walter Mondale and John O'Leary (then head of the Federal Energy Administration) said that "sacrifices" such as installing home insulation—a rather profitable venture of questionable discomfort—would be called for. Thus the President, following constant advice from the media, hinted that we weren't doing enough; look at all those gas guzzlers, he admonished. Yet today's cars "guzzle" 25 per cent less gasoline per mile than those made in 1973, in spite of constant real gasoline prices after the initial price increases following oil embargo. Clearly, the President and the public have confused perceptions about conservation and its measure.

To eliminate this confusion, we can describe energy use by denoting the level of physical or economic activity in a particular sector as O_x, and the energy use per unit of output as I_x. The intensity (I) can be measured as the energy directly applied, or as the direct energy plus that emobdied in other resources also used but supplied upstream. In either case, the energy consumed in this activity E_x is given as:

$$E_x = O_x \times I_x.$$

This notation suggests that we consider the total consumption (E) as the product of two vectors O and I—representing, in effect, the entire economy.

Obviously, changes in either the O_x—the mix or activities—or I_x—the intensity of each activity—can affect the total E. Economic growth, for example, increases the absolute size of O. Smaller homes reduce the component of O related to space conditioning, while added insulation reduces the intensity of heating. Some measures, such as small cars, involve changes in both O and I; lifestyle or behavioral changes often fall on this boundary. During the post-war period for example,

ownership and use of autos increased far faster than GNP, a factor that tended to push up the energy intensity of the whole economy. At the same time the manufacturing sector decreased in energy intensity. Obviously, sole consideration of total use or of oil imports would obscure the important dynamic changes in energy use or imports. I_{auto} has decreased dramatically since the embargo, while the distance traveled per capita by car has not increased at its historical rate. Given that gasoline prices have not increased in real terms after the initial spurt in early 1974, one would have to conclude that the U.S. is conserving energy in the important sector of auto transportation.

Moreover, as consumers and business people discover that there is profit in reducing energy intensities, they may be less interested in "moral war" and more interested in obtaining loans, grants, or at least competent advice covering profitable conservation investments. Great lifestyle changes (notably changes in the relative values of the O_g) may occur over longer periods of time in response to energy and other concerns. But talk of conservation must sort out the definitions of conservation and focus on the proper measure: what is being conserved. After all, confusing a sacrifice with a benefit is no small matter.—*L.S., J.D.*

Just as energy conservation is a response to a new energy price era, so significant substitution away from energy can dampen price pressures and permit a less convulsive development schedule for energy sources that now are technically, politically, financially or environmentally uncertain. And our early introduction of energy conservation measures will mean that the rate of usage of the new resources—which may or may not be environmentally benign—will, at any given time, always be lower in the future than if we had not begun to use energy more sparingly.

SOME ENDURING COMPLEXITIES

As we have said, energy conservation reflects the response of energy users to factors dominated by, though not necessarily limited to, prices and scarcity. Other interconnected issues include policies dictated by national security, environmental quality, and social impacts. Our understanding of the economics of substitution of non-energy resources for energy is improving; our knowledge about the speed of behavioral change or shifts in the mix of goods and services as a function of energy prices and policies remains far from perfect. In any case, we deem it important to delineate some of the principal forces that activate the conservation response, observing however, that the mere existence of these possibilities and a discussion of where rationality seems to lie does not guarantee implementation. (The social equity implications of higher energy prices that deter Congress from removing price controls illustrate one such issue, but this matter requires its own essay.)

From a physical standpoint, important tasks are performed with widely differing energy intensities, and we are far from thermodynamic limits. Our choices of how much energy to use depend on how the cost of energy and its substitutes interact with technology, lifestyle preferences, public policies, and institutional barriers to changes in energy-use patterns that could result in conservation. The historical record of both U.S. and foreign energy use shows considerable flexibility in energy needs—seen either from a technical (resource substitution) viewpoint or a behavioral/lifestyle viewpoint. Thus we can expect that conservation will play a great role in the energy future.

Keep in mind that conservation is not simply an issue of waste versus non-waste; the boundary line between these two extremes is defined both by economics and by tastes and preferences. In this light, however, it is nonetheless possible that growing worldwide energy consumption is raising consciousness among people in industrial nations over the moral implication of high—or low—energy consumption levels. While our economic definitions of energy conservation imply that economic considerations may be the most important criteria for determining the desirability of energy conservation strategies, we recognize the collateral importance of such difficult questions as waste, lifestyles, and growth itself in connection with energy conservation. But from the standpoint of clarity, these issues are best taken upon their own merit. If our discussion appears, therefore, to have imposed narrower bounds on the scope of energy conservation than some persons would prefer, meaningful payoffs—to energy users and to society—can still derive from soundly conceived conservation approaches within even a restricted framework. Perhaps the most pressing need for research today is to identify such payoffs—in their physical, economic, and social dimensions. We suspect that energy conservation offers the potential of large benefits to society. If that is so, conservation will play a decisive role in future demands for energy resources.

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THE IMPACT OF ENERGY CONSERVATION ON THE U.S. ECONOMY

(By Alvin Kaufman)*

INTRODUCTION

Energy conservation appears to be a concept whose time has come. Its implementation can reduce, but not eliminate, our need for additional energy. A reduction in our incremental energy requirements can reduce our vulnerability in foreign affairs and improve our balance of payments position. Conservation is also said to be less polluting and less expensive than energy derived from new sources. Despite these advantages, energy conservation has social, environmental, and economic costs as well as benefits. Whether the benefits outweigh the costs is dependent, in large measure, on one's definition and perception of conservation, as well as on one's scale of values. Energy conservation should not be looked at in isolation, but from a broader economic and social perspective, although this is difficult to do. The costs and benefits of reduced energy demand must be measured against the costs and benefits of other goals of society, such as enhanced economic opportunities, in order to arrive at the required trade-off between goals. The institution of energy conservation measures could mean a change in our way of living and our way of doing business. As a consequence, before embarking on a major conservation program, we had best understand the potential impacts of this regime. Among the possible trade-offs are the impacts on our economy, environment and national security. In this paper we will attempt to derive some measure of the economic impact of energy conservation on the U.S. economy. In doing so we will be dealing with only one small piece of the problem. A more complete evaluation of costs and benefits would have to consider effects on a large number of items such as foreign affairs, improvement in the balance of payments, environmental impacts, and so forth.

Energy conservation can be instituted as a little energy conservation, or a lot, or any degree in between. Therefore, depending on the impacts, the tradeoffs, and our value system, we can develop a conservation program to achieve the desired multiple goals.

CONSERVATION: CONCEPT AND DEFINITION

In any discussion of the economic impacts of energy conservation one finds a wide range of opinion somewhere between the sublime and the ridiculous. On the one hand, we are told that the great bulk of our energy is utilized for essential purposes and cannot be substantially reduced without harm to our economy and our standard of living. On the other hand, other people maintain that conservation is necessary if we are to sustain our standard of living, and maintain economic growth.

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In large measure, these various perceptions of the economic impact of energy conservation are colored by the value system of the participants, the time frame within which they operate, and their expectations. This, in turn, determines the definition one uses for conservation; that in its turn, affects the kinds, diversity, and depth of impact that is perceived. For example, there are those who perceive conservation as necessary for human survival because resources are finite. To these people half of U.S. energy consumption is wasted.[1] One person's waste, however, may be another person's necessity. Some people may consider frost-free refrigerators and self-cleaning ovens as a waste of energy, but these items can save time and drudgery. In a society with a rising proportion of working women, they are worth the energy and the cost premium to a great many people.

In other cases the shift from the less energy efficient to the more energy efficient may, in the eyes of many people, be more trouble than it is worth. A move from the less energy efficient airplane to the more efficient train may not be attractive to many people due to the substantially increased time requirement for the use of the railroad, particularly to distant cities (six hours coast-to-coast by air versus some three to four days by rail). In short, in any discussion of conservation, it is important to make a distinction between the value judgments of social critics and the real costs that will be incurred by individuals and society.[2]

Given this propensity to assign impacts based on one's perception of the conservation concept, we should define the term before we proceed further. Webster's Dictionary defines conservation as careful preservation and protection, as well as the planned management of a natural resource to prevent exploitation, destruction or neglect.[3]

Preservation and protection implies, however, the postponement of consumption. This is not feasible, for we must consume energy to survive. Further, to produce and consume energy materials is to exploit and destroy, because once used these materials no longer exist in any energy form. So much for Webster.

In today's society there appear to be several major schools of thought as to what constitutes energy conservation. On the one hand, there is a group that appears to confuse the arbitrary measures to reduce energy use instituted during the 1973–74 embargo as conservation. These curtailment measures were instituted as a form of energy allocation, not as conservation measures.

To institute such measures over the long-term without a consensus of the population is to force one group's value judgment onto society, as well as to distort the economy.[4] The latter would occur since only the saving of energy would guide the measures imposed. Hayes has noted that curtailment could mean giving up automobiles while conservation can mean trading in the 7 miles per gallon status symbol for 40 miles per gallon commuter vehicles. Curtailment means a cold house; conservation can mean the well insulated house with an efficient heating system.[5]

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[1] Hayes, Denis. Energy: The Case for Conservation. World Watch Institute, Washington, 1976, p. 7.

[2] Darmstadter, Joel. Conserving Energy—Prospects and Opportunities in the New York Region. Resources for the Future, The Johns Hopkins University Press, Baltimore, 1975, pp. 98–101.

[3] Webster's New Collegiate Dictionary. G and C Merriam Company, Springfield, Massachusetts, 1973, p. 241.

A somewhat allied school of thought would consider conservation as a substitution of other inputs for energy resulting in the reduction of uneconomical or wasteful uses of energy. This is a somewhat broader definition, and at least implies an effort to maintain total cost at a constant level.

Energy use is largely determined by the existing stock of equipment, housing structure, buildings and appliances, as well as by the kind of economy. It is used not for itself, but to produce work, heat, light, etc., that result in comfort and consumer goods of various types such as refrigerators. As a consequence, the introduction of conservation measures must be evolutionary rather than revolutionary if we are to avoid imposing substantial costs on society. For example, the production of more efficient washing machines can be encouraged through incentives, disincentives, or standards of one kind or another. The new appliances would be more energy efficient, but somewhat more costly.

The initial impact of the introduction of such devices on national energy demand would be minor. As older machines were replaced by more energy efficient units, the impact on energy use would be compounded and substantial improvement would be noted. If, on the other hand, current machines had to be retrofitted to improve energy efficiency, substantial costs would be imposed on the economy and on individuals, not to speak of the energy drain in order to manufacture all those new parts, as well as disposal of the old equipment.

Inasmuch as energy enters into the production of every item and the maintenance of life itself, it is important that disruption be kept to a minimum. We must keep in mind that energy use is simply a means to an end. A primary role of conservation can be to alleviate the effects of rising energy prices through the adoption of economically efficient measures that serve the entire society.[6]

Another school of thought would regard energy conservation as a means of reducing energy growth rates in a technically efficient manner by a system that will result in the money value of the energy saving exceeding the cost required to achieve that saving.[7] Such a definition, however, does not explicitly take account of the broader costs and benefits resulting from conservation actions. As a consequence of the pervasive nature of energy in the economy and the value judgments that must be made, a somewhat less restrictive definition seems desirable.

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[4] Such value judgments and economic distortions would be most unwelcome if the opinions discussed in FEA Conservation Paper 49 can be considered representative of a large segment of the U.S. population. (The Gallop Organization, Inc. Group Discussions Regarding Consumer Energy Conservation. March 26, 1976, pp. 46).

[5] Hayes, cited in footnote 1, p. 9.

[6] Lind, Robert and Robert Nathans. Benefit Cost Methodology for Evaluating Energy Conservation Programs. Science Applications, Inc., for the FEA, Dec. 1975.

[7] This is phrased in various ways by various authors. See particularly: (a) Ford Foundation Energy Policy Project. A Time to Choose: America's Energy Future. Ch. 6, Energy, Employment and Economic Growth. pp. 131–151, Ballinger Publishing Company, Cambridge, 1974. (b) Schipper, Lee. Energy Conservation: Its Nature, Hidden Benefits, and Hidden Barriers. Summer Workshop on Energy Conservation, Lawrence Berkeley Lab. June 1, 1975, UCID 3725, ERG2. (c) Seidel, Marquis R., The Economic Benefits of Energy Conservation. Presented at Energy Conservation: A National Forum. Fort Lauderdale, Florida, December 1–3, 1975, pp. 29.

Herfindahl has stated that the goal of a conservation policy is to adjust output of a good over some time period in order to maximize the social return from all of the economic resources at the disposal of society.[8] Put another way, he is saying that conservation policy should be designed in a way that adjusts the trade-offs between competing interests so that the quality of life, over time, is improved, or at least sustained. To do so, may mean that conservation of a specific item will not always be a good thing. The conservation of one kind of resource may mean the sacrifice of some other resource that someone else may want to conserve. For example, conserving energy through use of more efficient air conditioners means larger heat exchangers and heavier compressors. These in their turn, will mean use of more metals than a less efficient air conditioner. Some may regard the conservation of the latter materials as of greater importance than saving energy. The costs and benefits must be weighed and a decision made. In such a weighing, the external costs and benefits imposed on others by the conservation action must also be considered. In those instances where the user does not, or cannot, take account of these external impositions, then regulation of the way in which the resource is used may be necessary.

Even in those instances where attention is paid to total social costs and benefits, the analysis may be deficient because the impact of the conservation action on the real income of particular individuals, regions or industries, may be of such magnitude as to make it socially undesirable to undertake that particular conservation activity. This again is a societal value judgment that will have to be made.

The foregoing discussion indicates that a desirable definition of energy conservation should, first of all, indicate a saving of energy, but, at the same time take account of the benefits and costs to society accruing from that action over a suitable time period. In short, conservation should strive for a tradeoff between the energy saving action and other societal wants so that the results will be an optimization of that intangible—the quality of life. To this end, we can define energy conservation as a series of energy saving procedures over the long-term that will optimize society's use of all its economic and social resources.

A possible method for determining such optimization may be through application of the concept of total productivity as put forth in 1961 by J. W. Kendrick in his book on productivity trends in the U.S. That is, if we are to achieve improved economic efficiency through better use of our energy resources then this use must not be obtained through such substantial declines in the productivity of other inputs that we end up less productive overall as a result of the conservation action. For example, if energy conservation results in improved capital productivity but decreased labor productivity then the gains from the one versus the losses from the other must at least balance so that we are not worse off than before. If the productivity losses exceed the gains then we have lost economic efficiency, and we may well have a misallocation of resources as a result.

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[8] Herfindahl, Orris G., What is Conservation? in Three Studies in Minerals Economics, Resources for the Future, 1961, pp. 1–12.

THE ECONOMIC IMPACT OF ENERGY CONSERVATION

Economic Impacts

The few studies prepared that deal with the economic impacts of conservation appear to agree that the institution of conservation measures will result in modest impacts on the economy, but will cause an increase in employment. The increased use of labor will be accompanied by a decrease in labor productivity, and presumably in a decline in average wages, according to these studies. None of the papers have estimated the impact on total productivity. It should be kept in mind that unless the lower labor productivity remains stable or improves, the impact could be inflationary, depending on what happens to aggregate demand.

The available literature anticipates that conservation will require large capital expenditures, but that these will be less than needed for supply expansion only. These studies also forecast that conservation will tend to keep the total cost of energy inputs constant, thus resulting in a reduction or stabilization in the cost of goods. The authors of these papers have generally assumed reduced wages, or, in some instances, implicitly assumed stable or improved total productivity. The anticipated decline in real price is presumed to cause an increase in discretionary income with a consequent rise in consumption and eventual economic growth.[9] This scenario may not be correct. Conservation may indeed maintain the aggregate cost of energy inputs at a stable level, but energy cost savings may be more than offset by capital and other costs incurred in implementing conservation measures. Further, the reduced labor productivity may not be fully offset by either the wage reduction or increases in capital productivity. The presumption of reduced real price may prove to be illusory. The area of tradeoff between energy and other costs is somewhat murky.

The studies also appear to anticipate some structural changes within the economy due to shifts from skilled to unskilled jobs, but some savants see no serious impacts on any industry, State, or region. The structural shift appears predicated on the assumed movement from machinery to physical labor. It would appear more logical that more efficient machines would be substituted for those currently in use, rather than going back to more labor intensive activities. A shift to more efficient machines would result in greater capital productivity and possibly higher labor productivity. A shift to unskilled labor would probably result in lower labor productivity which might not be offset by higher capital productivity. In any case, if our contention is correct, the result would be higher capital expenditures rather than a shift to less skilled workers.

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[9] The studies summarized above are as follows: (a) Hannon, Bruce. Energy Conservation and the Consumer. Science, July 11, 1975, Vol. 189, No. 4197, pages 95–102. (b) Lind, Robert C. Testimony before the Energy Subcommittee of the Joint Economic Committee. Congressional Record, pp. S3177–3179, March 10, 1976. Also a report by Lind and Nathans entitled *Benefit Cost Methodology for Evaluating Energy Conservation Programs*. Prepared for the FEA, Office of Conservation and Environment, referenced earlier. (c) Schipper, Lee. Energy Conservation: Its Nature, Hidden Benefits, and Hidden Barriers. Referenced earlier. (d) Seidel, Marquis R. The Economic Benefits of Energy Conservation. Referenced earlier, plus a series of other papers: The Regional Impacts of Industrial Fuel Use, September 1975, Office of Energy Systems, Federal Power Commission; Conservation Options for Energy Self Sufficiency, Presented before the Eastern Economic Association, Albany, New York, October 27, 1974; United States Energy Self Sufficiency, An Assessment of Technological Potential, Demand Curtailment, and Conservation Scenario, Office of Energy Conservation, FEO, January 7, 1974. 31 pages.

In a study prepared for the Congressional Research Service,[10] Energy and Environmental Analysis, Inc., concluded that "a conserving economy will strengthen not only our welfare, but our national security by making us less dependent on foreign supplies subject to embargoes and overnight price gouging." The authors then went on to note that there would also be some sacrifices required including reduction of consumer choices, more planning and government intervention in the economy, and sacrifices involving our lifestyle. Examples of the latter would involve utilizing smaller cars, returning bottles to the grocery store and reducing the thermostat in winter. The report concluded that the trade-offs do not require a reduction in economic prosperity, the abolition of a free-market economy, unstable prices, or a reduced level of national economic performance.

A somewhat more limited study has been prepared by the Conference Board.[11] That paper only discusses the industrial situation rather than general economic effects.

The Conference Board indicates that the decline in energy-output ratio over the 1947–71 period was due to the introduction of new technology, plus a shift toward less energy intensive industries within manufacturing. The basic material industries are energy intensive, and these declined in relative importance during the period under review. It should be accented that energy savings per dollar of GNP occurred at a time when energy was becoming cheaper relative to other goods. For example, energy prices fell some 24 percent relative to the general price level in the economy. From 1970–73, however, energy rose more rapidly than general prices, and turned up even more rapidly after the Arab embargo.

The Conference Board paper notes that the Project Independence Report found that a 10 percent relative increase in energy prices will result in a 2.1 percent decrease in average industrial energy demand in the short run, with a potential 7 percent in the long run. The anticipated greater decline over the long run is due to the fact that energy is used with durable equipment which is replaced over time.

If the 1947 energy to GNP ratio (106,600 Btu per $ GNP) had held constant to 1973, instead of dropping to 90,000 Btu, energy consumption in 1973 would have been 18 percent above the actual total of 76 Quadrillion Btu (Q). Thus, the savings by industry are obvious. If the energy-GNP ratio declined at the 1947–73 rate of 0.6 percent while GNP grew at 3.5 percent annually, the energy growth rate from 1973–85 would average 3 percent per year. On the other hand, if the decline in the energy-GNP ratio was at the 1970–73 rate (which also happens to be the 1920–66 rate) of 1.2 percent per year, the energy growth rate would be 2.3 percent. A 2 percent rate of decline in the energy-GNP ratio would drop the energy growth rate to 1.5 percent from 1973–85. (It would appear to this author to be more logical that the decline in energy-GNP radio would be at the long term rate of 1.2 percent over the next 15 years or so.) The Conference Board concluded that energy use and economic growth are certainly not independent of each other, but the link between them appears to be more elastic than previously assumed by a great many people.

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[10] Energy and Environmental Analysis Inc. The Implications of a Conserving Economy. Prepared for CRS, October 1974, page VII.

[11] Myers, John G. Energy Conservation and Economic Growth—Are They Incompatible? The Conference Board Record, February 1975, pages 27–32.

Major Studies

Aside from the studies just summarized, two major analyses have been published. These tend to contradict some of the results of the above. The two major studies are those contained in the Ford Foundation Energy Project Study,[12] as well as a recently published paper by Hudson and Jorgenson.[13] The Ford sponsored study utilized two analytical approaches. In the first case, the study looked directly at the energy-economy connection by preparing a nine sector input-output model of the U.S. economy. This approach comprised the Hudson-Jorgenson model. It will be discussed in some detail below, and only the Energy Project conclusions drawn from the model will be summarized in this section.

The economic model developed for the Project by Data Resources, Inc. (Hudson-Jorgenson) indicates that a transition to slower energy growth can be accomplished without major economic cost or upheaval. The model indicated that it is economically efficient to cut the rate of energy growth at least in half over the next 25 years. The chief conclusion of the Ford study is that substantial savings are possible in U.S. energy input without significant change in the present structure of the economy, and without sacrificing continued growth of real income. The model indicates that in the year 2000, real income would be 4 percent less than would occur without conservation, but would be above current levels. It tends to corroborate other studies in that a less energy intensive economy would not reduce employment, but would, instead result in a slight increase in the demand for labor.

The Ford study also selected eight individual energy consuming activities, prepared projections of their normal growth, and from these projections computed the impact of applying available conservation technology. The results derived from this analytical technique was similar to those using the Hudson-Jorgenson model. The general conclusion seems to be that neither the economy nor employment will be seriously affected as a consequence of reduced energy growth rates. The Ford Foundation Energy Project Study concentrates on technically efficient changes in specific activities for the reduction of energy demand, but requires that these changes be economically attractive or cost effective. In other words, the cost of achieving a saving in energy must not exceed the money value of that saving.

The study concludes that energy, employment and economic growth are interdependent, but the degree of dependence can be changed. The

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[12] Ford Foundation Energy Policy Project. Energy, Employment and Economic Growth. Chapter 6 in A Time to Choose: America's Energy Future, Ballinger Publishing Co., Cambridge, Mass., 1974, pp. 131–151.

[13] Hudson, Edward A. and Dale W. Jorgenson. U.S. Energy Policy and Economic Growth, 1975–2000. Bell Journal of Economics and Management Science, Volume 5, No. 2, 1974. Pages 461–514.

Ford report maintains that the slowdown in population growth indicates that economic growth may occur in less energy intensive sectors, in that an older and wealthier population will consume more services and high quality goods compared with current consumption patterns. The movement to a more service oriented economy could result in lower energy use, but this might be offset by growth of a leisure-time industry. That is, people might do more traveling for recreation, weekend ski trips, and to or from second homes.[14]

The Energy Project study further notes that the manufacturing sector of the U.S. economy realized significant energy savings in the past, even during periods of stable or declining relative prices of energy. This improvement, as measured by the decline in the energy output ratio for total U.S. manufacturing, was at the rate of approximately 1.6 percent per year. The energy output ratio is computed as the input of Btu's per constant dollar of value added. The Energy Project notes that a pre-embargo study indicates that a 2 percent rate of decline in this ratio was probable to 1980. Greater energy savings are now believed likely considering higher energy prices, the fear of future shortages, and possible government action.

The Hudson-Jorgenson Model.—The most comprehensive study of the impact of energy conservation on the economy presently available is that encompassed by the Hudson-Jorgenson model referenced earlier. The major points in that article have previously been summarized by the Congressional Research Service.[15] The model is comprised of two parts, a model of the U.S. economy and a submodel of the interaction of energy and non-energy industries in the U.S. economy.

Hudson-Jorgenson computed a base case assuming no change in U.S. or foreign government energy policy from 1974 onward. On this basis, the model calculated GNP growth at an average of 3.85 percent per year, in real terms, between 1975 and the year 2000; an inflation rate averaging 3.76 percent; and energy growth rates at 3.2 percent during the 1975–80 period, 3.3 percent in the 1980–85 era, and 2.9 percent between 1985–2000. The rate of growth of real GNP was expected to slow below the historic rate because of a decline in the rate of increase of the labor force in succeeding years. The computed energy rate was somewhat lower than historic rates because of increased fuel prices, interest in energy conservation, the changing structure of the economy, the replacement of existing capital equipment with more energy efficient capital and because of shifts in output toward less energy efficient forms. The base case indicates substantial increases in electric use, with electric prices declining 2.4 percent in the 1975–85 period in real terms, and 5 percent in the 1975–2000 period.

After computation of the base case, the model was used to evaluate the impact of a series of tax proposals on both energy and the economy. The tax proposals tested were uniform rates of tax levied on the energy content of fuels.

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[14] Schurr, S. H. and Joel Darmstadter, The Energy Connection. Resources, RFF, Fall 1976, p. 6.

[15] Hack, David B. The Hudson-Jorgenson Model of Energy Policy and Economic Growth: Analyses of Energy Policy Alternatives. Science Policy Research Division, CRS. TP 300, July 31, 1976.

Inasmuch as the Btu content of each fuel is different, the tax per physical unit varies by fuel. The testing was undertaken in two steps. In the first instance the impact of various rates of Btu tax on the economy by 1980 were determined. In the second case, an evaluation of the specific tax proposal required to eliminate all energy imports, with the exception of petroleum for fueling ships and aircraft abroad, was prepared.

The various tax rates tested in the first step ranged from a high of 50 cents per million Btu to a minimum of 10 cents (approximately $3 to $.60 per barrel equivalent). These calculations indicated a decline in energy use by 1980, relative to the base case, ranging between 8 percent to 1 percent (Table 1). The model indicates that the shift away from energy will mean a reduction in the use of capital and materials, as well as the adoption of more labor intensive production techniques in the manufacturing sector of the economy. For the entire economy, however, energy substitution will result in the use of more capital and labor.

For our purposes we have assumed the various tax levels as a proxy for energy conservation measures, and have translated the impact of the tax level into an equivalent energy growth rate as shown in Table 1. It will be noted that the decline in energy use results in a modest decline in GNP by 1980, and a modest increase in GNP price compared with the base case. The major impact of the Btu tax, however, is on energy prices. These would rise substantially compared with the base case, particularly in the case of coal, gas, and refined petroleum. Whether this would also be true if the reduced energy growth rates were achieved in some other way than through a tax is not known.

It should be noted that these shifts from the base case do not denote an actual decline from current levels, but rather a drop compared with what would have occurred if energy demand had continued to grow at the 3.2 percent per year figure anticipated in the base case. There is, of course, a possibility that the 1980 date may be too close as a planning horizon, so that all of the impacts have not quite worked through the economy by that date.

Hudson-Jorgenson also tested a tax which would start at 0 in 1975, rise to 50 cents per million Btu in 1980, and to $1.35 per million ($8 per barrel equivalent) in 1985. The $1.35 figure, according to the model, would virtually eliminate the need for imports, and would reduce energy use 16 percent compared with the base case. This constitutes a 40 percent increase in energy prices in order to eliminate imports by 1985. The result of that tax program is indicated in Table 2. The percentage figures, once again, are changes from the base case rather than actual declines in the various indicators. It should be noted that this tax program results in a modest drop in real consumption and real GNP by 1985 compared with what would have occurred in the base case. The price level, as measured both by consumption prices and GNP prices would increase.

The conclusion that can be drawn from the Hudson-Jorgenson study is that a decline in energy use need not be traumatic for the U.S. economy. The suitability of the model, and thus our ability to draw such a conclusion, is discussed below.

Some Comments on Models.—Economic modeling is a relatively young art. The effort to model the connection between the economy and the energy sector is of even more recent vintage, perhaps as much as 5 years. These efforts tend to be rather primitive.

Energy-economy models tend to fall into two broad classes: the econometric models and those that attempt to optimize. The latter have difficulty in simulating the often non-optimal, and perhaps irrational, behavior of the real world, while the econometric models have difficulty in grappling with technologic change.

The studies discussed above use standard methodology, and while a useful tool, are somewhat limited in policy analysis. Most of the comments presented below on the drawbacks of the Hudson-Jorgenson model apply with at least equal force to the other studies discussed above.

The development of the Hudson-Jorgenson model represents a breakthrough in the modeling effort to link the energy sector to the rest of the economy. This is the first effort to introduce the substitution of capital, labor, materials and energy for each other as a function of the price of each.

Despite this landmark effort, the H–J model, as currently constituted, has a limited usefulness for policy analysis. Khazzom has noted that the submodel dealing with the total economy is relatively small so that crucial assumptions have to be made regarding the allocation of investment, possible changes in productivity and the unemployment rate. These intuitive assumptions may then have an impact on the conclusions put forth by the model.[16]

In addition, the model was developed from historical data for the 1947–71 period. Considering the changes that have occurred since 1971, it may no longer be a reflection of the real world. This weakness is compounded by the manner in which the model is constructed. The input-output coefficients for a point in time are computed as a function of input prices. As a consequence, there is a built-in implicit assumption in regard to future technology in the sense that the weights derived for the 1947–71 period are presumed to also prevail in the future.

Further, a very small data sample was used to develop the input-output matrix. Information was only available for the years 1947, 1958, and 1963. The intervening years for the non-energy sectors were derived by interpolation, with the 1964–71 period assumed at the 1963 value. Thus, a rather small data base was used to erect a large edifice.

Another problem is the limited size of the input-output matrix. Only 9 sectors are covered; of these 5 are energy related, leaving 4 to cover the rest of the economy. This high degree of aggregation may mask major impacts and shifts between various industries.

As a consequence of the above difficulties, the H–J model still has a way to go. It is, however, a giant step forward in the development of models to test alternative energy policies.

There are currently underway, efforts to improve the H–J model by integrating it with the Brookhaven National Laboratory (BNL) linear programming and input-output models.[17] This work, sponsored by ERDA, will be used in the analysis of alternative Government polies. At the moment, two types of policy variables are being analyzed. On the one hand, the impact of taxes and subsidies on energy production or consumption is being tested, while on the other hand the long-run effect of research and development expenditures on income, output, employment, capital and imports is being examined.

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[16] Khazzoom, J. Daniel. A Discussion Paper of Hudson-Jorgenson's Model of U.S. Energy Policy and Economic Growth, 1975–2000. Proceedings of the Workshop on Modeling the Interrelationship Between the Energy Sector and The General Economy, Electric Power Research Institute Special Report 45, July 1976, pp. I–18 to I–32.

These efforts involve 4 models, 2 from Data Resources (DRI) and 2 from BNL. The DRI models include an economic growth model for long-run consumption and investment trends (along with the associated labor and capital requirements), together with an interindustry energy model for estimates of economic output and price structure as well as the energy-economy interaction.

BNL is providing an input-output model for estimates of energy uses and labor, capital and material requirements (actually by the University of Illinois), together with a linear programming allocation model. The latter estimates energy sector physical flows and the associated least cost energy mix.

In addition, the Electric Power Research Institute is sponsoring an Energy Modeling Forum (EMF) headquartered at Stanford University. The initial EMF project is an effort to study the link between the economy and energy through comparative tests of 6 computer models. The models being used include: Hudson-Jorgenson; Hnyilicza at MIT; Kennedy-Niemeyer at the University of Texas; Wharton Econometric; PILOT at Stanford; and the Brookhaven DRI effort.

A set of six scenarios with common assumptions have been designed. These will be run through the various models and results compared. To date, results are not yet available.

An Evaluation of Economic Impact

In an earlier section, we defined energy conservation as a series of energy saving procedures over the long-term that optimize society's use of all its economic and social resources. It follows that the overall economic effects of measures meeting this definition will be either nonexistent or beneficial. In this context, it may be useful to review the possible impacts from the recently enacted series of energy conservation measures.

The Energy Policy and Conservation Act includes automobile efficiency standards, appliance labelling and efficiency improvement goals, voluntary industrial conservation and Federal-State conservation programs. The FEA estimates that these items can reduce energy demands the equivalent of 2.5 million barrels of petroleum per day, or approximately 5.3 Quadrillion Btu per year (Q), assuming a barrel contains 5.8 million Btu. The auto efficiency standards, currently set at 20 miles per gallon by 1980, 25 by 1985 and 28 by 1990 are believed to be the major conservation measure with estimated savings of 1 million barrels per day (2 Q) by 1985.[18]

The above savings are not cost free. The FEA estimates that in addition to the capital required for supply expansion, capital will be needed for conservation. In arriving at these estimates, the assumption was made that any investment in conservation is not likely to be greater than the net present value of energy savings generated by that capital expenditure. This approach was used because it is not clear which part of the cost is conservation and which part is for other reasons, such as obsolescence. On this basis, and further assuming an average energy price of \$3.75/million Btu in 1985 (1975 dollars), a discount rate of 8% and 40–80% of the energy savings requiring investment, FEA estimated conservation capital requirements as follows:

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[17] Behling, D. J. and Robert Dullien. A Combined Linear Programming and Econometric Systems Analysis of the Relation between Energy, Growth and the Economy, Brookhaven National Laboratory, BNL 21281, 1976.

[18] National Energy Outlook, February 1976, FEA, Washington, D.C., pp. 23–24 and 318–320.

	Billion
High	\$327
Middle	242
Low	164

These requirements would be spread throughout the economy, and might substitute to some degree for capital for supply sources. If so, there would be a somewhat different mix of expenditures, possibly on the order of \$460 billion for increased energy supplies, and \$250 billion spread among insulation, automobile, and equipment manufacturers. The precise nature of this split is unclear.

In addition, the bill extending the life of the FEA (H.R. 12169, 94th Congress) provides for development of Federal energy conservation standards for new residential and commercial buildings, a \$200 million grant program for weatherizing existing homes occupied by low income people, an energy conservation information program, a \$2 billion loan guarantee program for public and commercial buildings, and a \$200 million demonstration program to identify energy conservation incentives for home improvements.[19]

The FEA has estimated savings from thermal efficiency standards for new buildings at 300,000 barrels per day, and from an insulation tax credit at 100,000 barrels per day. These savings are estimated to accrue by 1985. It would thus appear that close to 3 million barrels per day, or 6 Quadrillion Btu annually, could be saved by 1985 through the various conservation measures stipulated by the Congress.

The bulk of the savings would accrue from improved auto efficiency, better building insulation, and more efficient appliances, with at least a third of the savings resulting from the auto efficiency improvements alone.

Considering the importance of the auto efficiency improvement we have elected to attempt to analyze the economic impacts that will flow from its implementation. To do so requires that we decide if auto efficiency fits our definition of conservation using total productivity impact as our guide. To this end we have constructed a possible, but certainly arguable, scenario.

We have assumed that the improved mileage will be attained by producing lighter weight cars rather than more efficient motors. This will be achieved through shrinkage of outside dimensions and greater use of lightweight materials such as plastics, aluminum, and lightweight steels. The shift to these somewhat more expensive materials coupled to the need to remodel plants to handle the new models, should result in a higher real cost per car in the short-run, but may result in lower costs over the long-run. The lower real long-run costs would occur as a consequence of generally lower materials costs because of smaller sized cars plus economies of scale resulting from completion of factory retooling plus fullscale output of the newer materials. It is assumed that if these costs were discounted over time, the present value of the benefits would be positive.

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[19] Ribicoff, A. The Congressional Record, August 5, 1976, p. S13554. See also, Conference Report, 94–1392, House of Representatives, 94th Congress, 2nd Session, August 4, 1976.

The lower long-term cost of the car plus reduced operating costs due to substantially improved miles per gallon of gasoline may have two impacts. On the one hand, disposable income should rise thus spurring consumption of other products with a resulting rise in GNP.

GNP would rise in any case since there may be a shift in final demand from the extractive industries, such as petroleum, to auto manufacturing. Manufacturing activities generally generate greater direct and indirect efforts throughout the economy compared with extractive industries. This would be offset somewhat by the effects of the expansion of aluminum and plastics production—both of which are based on extractive industries. The latter is heavily dependent on petroleum, while aluminum requires imported ores.

The move to the newer materials may cause economic dislocation in the shortrun. The move away from traditional iron and steel producers would not only cause some hardship to that industry, but to the regions in which the steel plants are located. This would be offset by expansion of the new industries in other locations.

On the other hand, the lower auto operating costs may stimulate more driving and a demand for more highways. The increased road building would have a detrimental effect on the environment. Other environmental effects should be positive. The lower use of materials to produce the cars plus reduced fuel consumption should be environmentally beneficial.

Increased driving, however, could result in increased accidents. Since small cars tend to be less safe than larger cars, accidents could be more severe, thus imposing larger social and economic costs than might otherwise be the case.

To sum up, the short-run effects in terms of capital and labor inputs, together with anticipated regional dislocation, are all negative. Over the longterm, however, GNP may increase while labor and materials inputs remain relatively stable. Capital inputs should rise, but on balance total productivity should not suffer. The improved efficiency of a major element of our economy such as the automobile should optimize the use of our economic and social resources. We can thus conclude that the economic impacts, over the long term, should be desirable.

SUMMARY AND CONCLUSIONS

Energy conservation is a concept whose time has come. Before embarking on such a voyage, however, we should have some idea of the potential impacts, as well as what we mean by the term conservation. There are various perceptions of what conservation is. Some see it as an ethical issue, a necessity for human survival. Others view it in a cost-benefit context. That is, in terms of energy-saving versus time, convenience, or whatever. The goal of conservation policy, according to some authors, is to adjust the output of a good over some time period in order to maximize the social return from all of the economic resources at the disposal of society. In short, conservation should strive for a trade-off between energy-saving actions and other societal wants in order to result in an optimization of that intangible, the quality of life. For the purposes of this paper, we can define conservation as a series of energy-saving procedures over the long term that will optimiz society's use of all its economic and social resources. The overall economic effects of measures meeting this definition will be either nonexistent or beneficial.

In an effort to determine whether a particular conservation measure meets the above definition, we suggest the use of the concept of total productivity. That is, improved energy productivity should not result in such serious declines in capital or labor productivity as to cause a drop in total productivity. Thus, if a measure that reduces energy demand also serves to improve economic and social efficiency, rather than serving as a punitive measure, the economic impacts should be acceptable, and perhaps desirable.

Several studies have been published on this subject. All agree that energy demand reducing measures will result in modest impacts on the overall economy, but will result in an increase in the need for labor. It may well be that such measures would result in an increase in capital inputs as a consequence of the replacement of equipment with more energy-efficient machines, at a higher capital cost, rather than with more labor-intensive activity.

The Ford Foundation Energy Project, one of the major studies, concluded that substantial savings in energy are possible in the U.S. economy without significant changes in the present structure of the economy, and without sacrificing the continued growth of real income. The Hudson-Jorgenson model used by that project was also subsequently used to test the economic impact of various tax levels imposed to induce energy saving. The various taxes tested had a modest negative impact on the U.S. economy, compared with a base case.

The H–J model also indicates that a reduction in energy input would mean a reduction in the use of capital and materials in manufacturing, and the adoption of more labor-intensive techniques, compared with the base case. For the overall economy, however, the model projects the use of more capital and labor. The H–J model, however, has problems with a limited data base, and the highly aggregated interindustry submodel.

This model, like all models, must be used with great care as a policy tool. As an alternative, we have prepared a review of the expected impacts from the major energy saving measure enacted by the Congress—auto efficiency standards. This review indicates the short run impacts may be negative, but over the long-run GNP may increase. Total productivity should not suffer so that economic impacts, over the long term should be acceptable.

TABLE 1.—IMPACT OF ENERGY GROWTH ON THE U.S. ECONOMY, 1980[1]

	Base case[2]	Energy growth rate		
		2.9 percent	2.3 percent	1.6 percent
Tax rate (mBtu)	0	$0. 10	$0. 30	$0. 50
Energy demand (QBtu)	90	89	86	83
Energy consumption (Q) (percent change from base):				
Coal	14. 3	−0. 47	−1. 40	−2. 33
Gas	26. 9	−2. 83	−7. 80	−12. 04
Petroleum	39. 2	−1. 83	−5. 20	−8. 26
Electric	8. 9	−. 42	−1. 24	−2. 06
Energy prices (dollar per mBtu):				
Coal	. 68	+5. 68	+16. 94	+28. 33
Gas	1. 44	+4. 87	+14. 62	+24. 36
Petroleum	2. 04	+4. 57	+13. 71	+22. 85
Electric	7. 50	+1. 32	+3. 96	+6. 60
GNP		−. 09	−. 26	−. 42
GNP prices		+. 23	+. 69	+1. 07
Consumption		−. 12	−. 33	−. 53
Investment		−. 11	−. 31	−. 51

[1] Adapted from tables 16 (p. 502), 18 (p. 505), and 19 (p. 506) of the Hudson-Jorgenson article referenced in footnote 13 of the text.

[2] Energy growth rate equals 3.2 percent.

TABLE 2.—IMPACT OF AN ENERGY TAX, 1975–85[1]

	Year		
	1975	1980	1985
Base case energy demand (QBtu)[2]	77	90	105
Tax rate (cents per mBtu)	0	50	135
Energy demand (Q)	77	83	88
Coal	13	14	16
Gas	25	24	22
Petroleum	34	36	36
Electric	7	9	11
Imports	16	9	1
	Percent change from the base case		
Real consumption		−0. 53	−1. 22
Consumption price		+1. 34	+2. 41
Real GNP		−. 42	−. 99
GNP price		+1. 07	+2. 04

[1] Adapted from table 21, p. 509, of the Hudson-Jorgenson article referenced in footnote 13 of the [illegible]

[2] Assumes no energy tax.

ENERGY CONSERVATION AND A HEALTHY ECONOMY

(By Thomas F. Widmer and Elias P. Gyftopoulos)*

Energy Conservation and a Healthy Economy

It is only too well known that we are exhausting our finite store of fuels at an alarming rate, especially the gaseous and liquid forms. It's also painfully clear that we are investing more and more for new energy supplies and obtaining less and less for our money. International fuel prices have increased much faster than the prices of other commodities because of this scarcity of petroleum and natural gas and the high cost of new energy sources. Most indications are that this gap will keep widening for many decades to come. Fortunately, is is quite certain that we can re-optimize each energy-consuming task to achieve the same result at equal or lower cost, and use far less energy. In this paper we will show the firm technical and economic bases that underlie this seemingly bold assertion. We will show that there is an enormous opportunity for reduced energy consumption per unit of product in every sector of the economy; and if we do not take advantage of this opportunity, our economic well-being and security will be endangered.

Re-optimizing energy end-uses will, of course, require long-term commitments involving significant restructuring of all sectors of society. This restructing cannot happen automatically, because of many institutional barriers and many distortions of the free market system introducted by past decisions. But these barriers and distortions are not insurmountable. They can be largely eliminated if we attack them with a comprehensive energy policy, such as the accelerated conservation policy we propose.

TECHNICAL ROOM FOR CONSERVATION

The laws of thermodynamics give us a most convincing technical basis for estimating the possibilities for energy conservation. Specifically, the second law of thermodynamics affords a yardstick that is universally applicable to all fuels and all processes. The second law implies that energy has a "quality" about it and that this quality can only be degraded as energy is consumed to perform useful tasks. The "available work" in a system is a quantity that takes into account both the quality and the quantity of energy (*see "The Potential for Fuel Conservation" by Marc H. Ross and Robert H. Williams, February, 1977, pages 48–57*). This "available work" concept has been used in several studies to measure the efficiencies of various energy-using processes in our society, as a function of the task to be performed, rather than the particular device used to perform that task. Some of the efficiencies estimated in these studies are:

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*From Technology Review, June 1977, p. 31–40. © 1977 by the Alumni Association of the Massachusetts Institute of Technology. Thomas Widmer is Vice President of Engineering for Thermo Electron Corporation in Waltham, Massachusetts. Elias Gyftopoulos is Ford Professor of Engineering at M.I.T. Reprinted by permission.

—Residential and commercial space heating: 6 per cent,
—Residential and commercial water heating: 3 per cent,
—Air conditioning and refrigeration: 5 per cent,
—Automobile propulsion: 10 per cent,
—Steel production: 21 per cent,
—Petroleum refining: 9 per cent,
—Cement manufacturing: 10 per cent,
—Paper production: less than 1 per cent.

The total amount of fuel used in these applications is about 60 per cent of all U.S. energy consumption. The average efficiency of utilization, obtained by weighting each efficiency by the amount of fuel used for the purpose, is only 8.3 per cent. Moreover, the figure of about 8 per cent is believed to be fairly representative of the overall energy effectiveness throughout the economy. The 10 per cent efficiency given for automobiles actually overstates their performance considerably, since this calculation takes into account only the efficiency of converting fuel energy to tractive effort at the driving wheels. It is extremely difficult to specify auto efficiencies precisely because of various non-technical factors affecting the vehicle design, such as add-on hardware to enhance convenience, safety, comfort, etc.

We're not suggesting that energy efficiency will ever approach 100 per cent for real devices or processes, even in the remote future. We wish to emphasize, however, that the present low values of efficiencies indicate the enormous opportunity for energy savings and that no fundamental scientific barriers exist to prevent substantial improvements in energy end-use effectiveness. Even a modest improvement, for example from 8.3 to 9.3 per cent efficiency, represents a saving of almost 10 "Quads" per year at the 1975 consumption level (where a Quad equals 10^{15} Btu's). This is the energy equivalent of 4.6 million barrels of petroleum per day.

Some analyses mistakenly associate large energy savings with reduced economic activity. In 1972, for example, an analysis for the Chase Manhattan Bank stated almost fatalistically that "analysis of the uses of energy reveals little scope for major saving. The great bulk of the energy is utilized for essential purposes, . . . Conceivably, the use of energy for such recreational purposes as vacation travel and the viewing of television might be reduced—but not without widespread economic and political repercussions. There are some minor uses of energy that could be regarded as strictly nonessential—but their elimination would not permit any significant saving."

More correctly, a report by the Energy and Environment Division of the Lawrence Berkeley Laboratories answered that "more informed studies of energy use contradict this analysis. Especially misleading is the subjective phrase *essential purposes*, which obscures the whole question of efficiency. Careful analysis of energy use has revealed an enormous potential for energy conservation. The most recent forecasts from the Energy Research and Development Administration suggest that U.S. energy needs in the 1990s could be 20 to 40 per cent below what was previously expected, as higher energy prices and new end-use technologies help Americans squeeze more economic and personal well-being from every Btu."

The process known as cogeneration offers an impressive example of the energy savings obtainable using only current technology. Cogeneration—the combined production of electricity and industrial process steam—offers an opportunity for conservation because steam for industrial processes is produced at relatively low pressure and temperature and, hence, does not make good use of the high-temperature heat available from fuel combustion. The common practice of producing low-pressure process steam in a fuel-fired boiler is therefore thermodynamically inefficient. The practice can be made much more effective by first producing high-pressure steam in a boiler, then expanding this steam through a turbine to generate electricity and then exhausting the steam at the appropriate pressure level needed for the desired process.

The electricity thus produced is obtained at an additional fuel consumption rate less than half that achieved by the most efficient central station power plant. Since over 40 percent of industrial energy—or about 16 percent of all the nation's energy—is used in the form of process steam, the potential savings are enormous. In West Germany, cogeneration accounts for over 18 percent of electrical needs, compared to only about 5 percent in the U.S. A recent study by Thermo Electron Corp. for the Federal Energy Administration revealed that in just three industries—papermaking, chemicals, and petroleum refining—there exists the opportunity to produce over 34 percent of all the nation's electricity by means of cogeneration and waste heat recovery.

While long-term dramatic improvements in end-use efficiencies can probably be made throughout the economy there will be a significant capital cost involved, unlike the case with many of the simple measures already implemented in response to rising energy prices. Such conservation actions, involving the trade-off of energy cost savings against initial capital costs, deserve the most careful attention in formulating a new U.S. energy policy.

SKYROCKETING SUPPLY COSTS

To understand just how economically sound conservation measures really are, we can compare capital requirements for various supply and conservation measures.

On the supply side, diminishing fossil fuel resources have necessitated the investment of enormous amounts of capital per unit of energy production capacity. True, Middle East reserves are still readily accessible. However, most new petroleum or natural gas production areas—such as the U.S. outer continental shelf, North Sea, Alaska, etc.—require anywhere from $10,000 to $15,000 for each barrel per day of equivalent fuel energy provided. This translates into a capital demand of about $4.5 to $6.8 billion for every Quad per year of energy delivered. Synthetic gas and oil obtained from coal will be even more capital intensive, probably requiring more than $10 billion per annual Quad.

New coal supplies are still obtainable at a capital cost of $1.5 billion to $2.0 billion per annual Quad. However, coal mining, processing, and combustion produce serious environmental and safety problems which may ultimately limit the rate of coal consumption, or at least cause increases in the cost of supply. Moreover, coal cannot be as flexibly used as oil and gas. The industrial sector could undoubtedly substitute more coal to produce steam, for example, but increasing our reliance upon coal will depend mainly upon its greater use by electric utilities or the development of economical gasification methods.

Electricity as a form of energy requires a much higher capital investment. For every Quad per year of delivered electricity, the capital investment in facilities for fuel supply, generation, transmission, and distribution will range from $45 billion for coal-based systems to about 1.5 times as much for nuclear generation. We cannot directly compare electricity costs with those for coal and petroleum fuel resources, because electricity has far greater flexibility of usage than does raw fuel. Even so, the capital cost of coal-based electricity is about $15 billion per annual Quad of coal converted to electricity, or more than eight times the capital cost of raw coal supply, itself.

Despite its high capital cost, electricity occupies a unique and vital place in the spectrum of energy forms. Many tasks exist that can be performed only by energy of the highest thermodynamic grade, such as electricity. So electricity is an essential part of a balanced energy supply system. Electricity should be recognized, however, as having both special properties and high capital intensity, and therefore should not be used as a convenience fuel, as for home heating.

The enormous and growing capital required to develop new energy supplies could injure the entire economy. According to even highly optimistic projections of economic growth and capital formation, the U.S. economy is unlikely to produce more than $2.7 trillion for all purposes over the next decade. Assuming that the long-standing ratio between business and residential investments prevails, about $1.8 trillion will be available for all business investments for both new capacity and replacement purposes. A New York Stock Exchange report estimated that, of that capital, the energy supply industry would require more than $800 billion.

It is an alarming prospect that we might have to allocate almost half of all business capital to energy supply investments alone. In the recent past, the energy industry has consumed only about one-fourth of total U.S. business capital, and even this fraction had created growing stresses in the capital markets. Unless this trend is reversed, we will soon be devoting so much of our scarce capital resources to energy production that other business needs will suffer a severe lack of investment funds.

A BARGAIN IN CONSERVATION

In contrast to the rising expenditures needed to develop diminishing fuel reserves, conservation can be put to effective use with substantially smaller capital commitments.

For example, for only a modest investment we could reap large improvements in the energy efficiency of the common window air conditioner. Data published by the Federal Council on Science and

Technology showed that three commercially available room air conditioners with exactly the same 5,000-Btu-per-hour cooling capacity had the following initial costs and energy consumptions:

—$120 for a 4.58 Btu/watt-hour unit;
—$140 for a 5.80 Btu/watt-hour unit;
—$165 for a 8.70 Btu/watt-hour unit.

As you can see, by investing only $45 in additional first cost—38 per cent more—one can obtain an efficiency improvement of 89 per cent.

Since the air conditioner is likely to be used only 500 hours per year, or about 6 per cent of the time, the energy saving will be 258 kilowatt-hours per year. However, its usage is likely to coincide with the period of highest summer electrical demand. Hence, the $45 increment for conservation can be viewed as a direct substitution for more than one-half kilowatt of expensive utility system peak generation and distribution capacity, having a value of at least $200.

Unfortunately, user benefits do not reflect the same degree of advantage indicated by the capital cost comparison. In fact, the consumer would save only about $18 per year for 500 hours of use, yielding a gross payback of about four years. Even this moderately attractive return can be illusory when the ultimate consumer does not participate in the initial purchase decision, for instance if he lives in a rental apartment or housing equipped by the builder rather than by the owner.

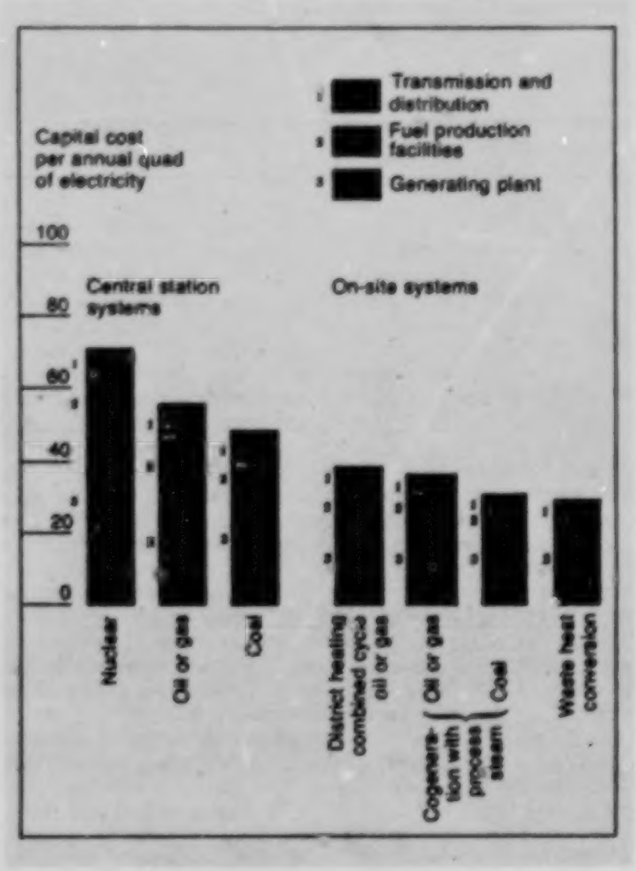
Another example of high return on conservation investment is the case of waste heat recuperators. Recuperators can provide fuel savings of at least 25 per cent on most high-temperature furnaces used for controlled-atmosphere metal processing. The cost of such recuperators is about $1,300 for each combustion burner on a radiant tube furnace, with fuel savings amounting to about 125,000 Btu per hour per recuperator. Under normal plant operating schedules, this represents capital cost investment of $1.5 billion per annual Quad of fuel saved, compared to the $6 billion per annual Quad cost of new domestic gas supply.

With the recent sharp rise in industrial gas prices, the payback period for recuperators has shortened to about three to four years, a range that is still only marginally attractive to most industrial firms whose capital budgets can barely cover essential or "main-stream" business investment needs.

The generation of electricity from waste heat also represents an excellent investment opportunity. A recent engineering study conducted for a major cement manufacturer revealed the opportunity for producing 4,700 kilowatts of electricity by capturing waste heat from the exhaust of the company's cement kilns using a steam-electric bottoming cycle system. The cost of the system was $2.7 million.

If that 4,700 kilowatts were to come half from a new coal plant and half from a new nuclear plant a capital investment of more than $7 million would be required for fuel supply facilities, generating apparatus, and transmission and distribution equipment. In terms of energy capital effectiveness, the waste heat recovery system costs less than $25 billion per annual Quad of electricity, or less than half that of the average investment required for new coal and nuclear utility capacity.

It is noteworthy that in this particular case the conservation equipment was not installed, and the cement plant continues to purchase its electricity at 2.5 cents per kilowatt-hour. Allowing for operation and maintenance of the steam-electric bottoming cycle, the savings would have been $775,000 per year, i.e., the energy conservation investment would be recovered in about 3.5 years. Since this payback did not meet the company's requirements for discretionary investments, the proposal was rejected. As a result, the failure to implement this one conservation measure in one cement plant causes a continuing loss to the nation of 180 barrels per day equivalent petroleum. In general, capital investments for on-site generation of electricity by various schemes are smaller than those for central power stations, as shown in the chart below.



These few examples have only scratched the surface of conservation investment possibilities for industry. We have identified numerous examples of energy conservation investments in the steel, aluminum, oil refining, paper, chemical and other industries that significantly outperform corresponding investments in new energy supplies. In other sectors of the economy cost effective opportunities might include:

Substitution of diesel engines for gasoline engines in light trucks, which would require less capital per unit of fuel saved than does new petroleum supply capacity.

Weight reduction in automobiles through material substitution, which can actually decrease total capital cost.

Reducing passenger space is also cost-effective, but this type of energy conservation involves changing life-style and consumer tastes rather than improving technical efficiency, which is the focus of this discussion. It is important to clarify the distinction between these two different kinds of conservation, and to dispel the popular misconception that conservation is equivalent to belt-tightening. Such actions, usually taken in response to immediate crises, tend to obscure the real and lasting benefits of conservation through improved end-use effectiveness.

SOME BARRIERS TO CONSERVATION

Because of their economic attractiveness, one might expect capital investments in conservation to proceed at a faster rate in the industrial than in the residential or other sectors of the economy. After all, in industry energy users are likely to have a greater awareness of first-cost versus operating-cost tradeoffs. However, industry has not significantly outpaced other sectors in improving its energy efficiency. Where industrial conservation investments have been made, the decision has often been influenced by factors other than simple economics; for example, the threat of outright curtailment of production due to fuel interruption.

We've identified several reasons behind industry's reluctance to invest in energy-efficient equipment:

Most energy-user companies must maintain conservative debt-to-equity ratios because of uncertainty about the future availability and cost of financing. Conservation investments, therefore, do not usually command high priority in the competition for limited capital funds. These funds must first be reserved for essential mainstream business purposes, such as tooling new products and expansion of capacity to meet market conditions.

Criteria for investment payback are more stringent for manufacturing companies than for regulated utilities whose risks are lower.

The pricing of industrial electricity and fuel is largely based on average, rather than incremental costs of supply.

These factors tend to create a major distortion in the deployment of scarce capital resources to achieve the optimum balance between investments in new energy supply and in energy conservation.

A PLAN FOR ACCELERATED ENERGY CONSERVATION

A new government policy stressing energy conservation could produce major changes in our energy usage patterns in a relatively short time and without impairing economic expansion. By comparing energy demand estimates, with and without an accelerated conservation approach, one can really see the important differences that might be anticipated during the next decade.

For our scenario of life *without* accelerated conservation, let us examine a 1975 report by the Federal Energy Administration (F.E.A.) entitled, "National Energy Outlook." In its ten-year forecast for U.S. energy production and usage the F.E.A. predicted that higher energy prices alone could cut 1985 consumption from an unconstrained demand level of 123 Quads to about 107 Quads. Demand would be restricted further, to about 101 Quads, by some additional conservation measures which were not specified.

Under the F.E.A. plan, electrification was to increase from 1.93 trillion (24 percent of all 1975 energy input) to 3.35 trillion kilowatt-hours (more than 34 percent in 1985). Thus, with the real G.N.P. expanding at about 3 percent per year (34 percent over the decade), total energy was to grow by 2.8 percent per year and electricity by 5.5 percent per year. The plan was expected to produce almost no change in the distribution of energy by the end-use sectors relative to the pattern existing in 1975: residential and commercial would still comprise 37 percent of consumption; transportation, 24 percent; and industry, 39 percent.

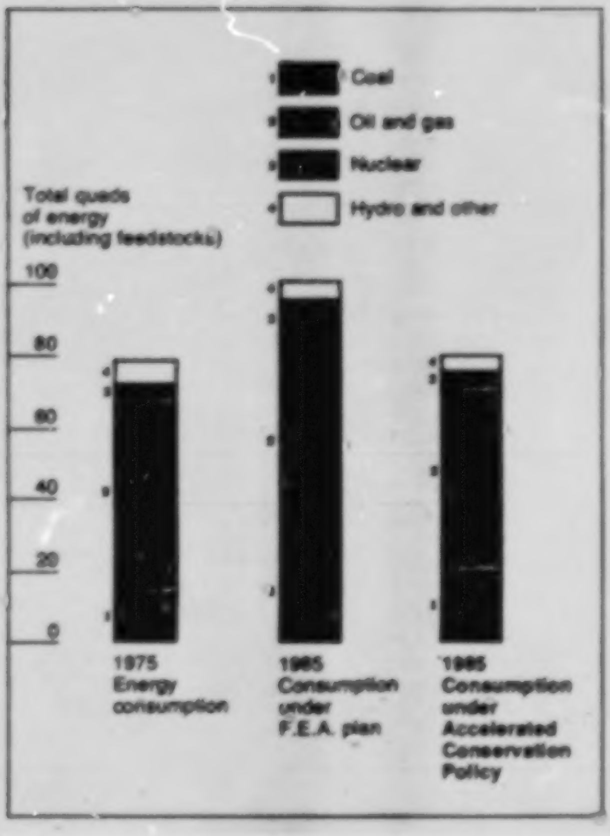
The F.E.A. projected a shift in energy resources, with coal rising from 18 per cent in 1975 to 22 per cent in 1985, nuclear energy rising from 3 per cent to almost 10 per cent (accounting for over one-fourth of electricity generation), and oil and gas declining from 74 per cent to 63 per cent (the major reduction occurring in electric utility consumption of these fuels).

To provide a framework for evaluating these forecasts we have devised an alternative plan which stresses conservation measures. Based upon the same growth in real G.N.P. as assumed in the F.E.A. plan—approximately 3 per cent per year—the alternative approach postulates no substantial social changes or curtailment of living standards. This "Accelerated Conservation Policy" is by no means the only plan that might be considered, but it illustrates some of the benefits realizable by more effective energy end-use.

A key element of the conservation policy is the transfer of a major portion of the capital now marked for new energy supplies into investments in energy conservation in each of the end-use sectors. An important result of this transfer will be a major reduction in the total amount of capital required for all energy investments.

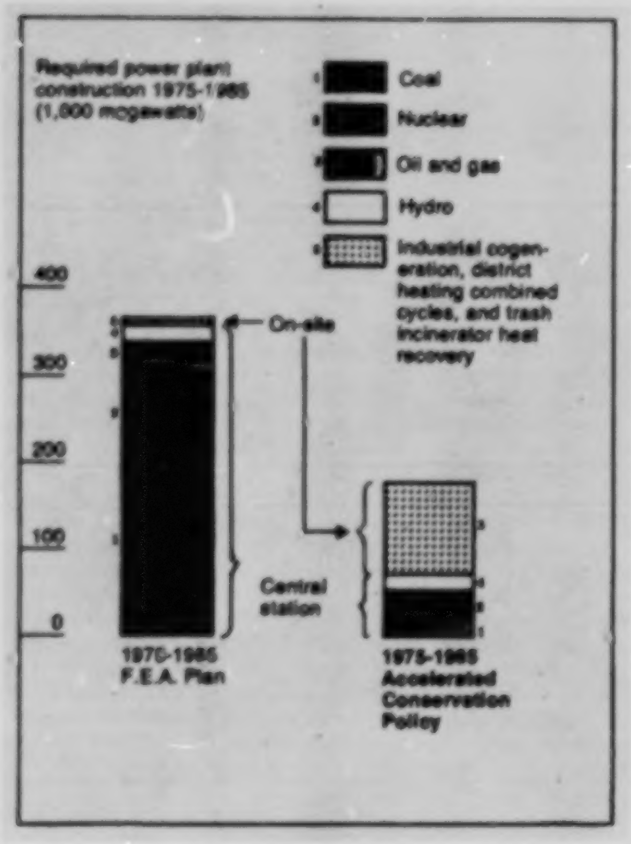
The Accelerated Conservation Policy calls for sharp curtailment in the rate of growth for electricity, the most capital intensive form of energy. It also calls for certain specific measures to improve end-use efficiencies, including:

Enforce the mandatory automobile fuel economy standards already enacted by Congress. Impressive progress is being made toward meeting the 1980 criterion of 20 miles per gallon (m.p.g.), particularly by



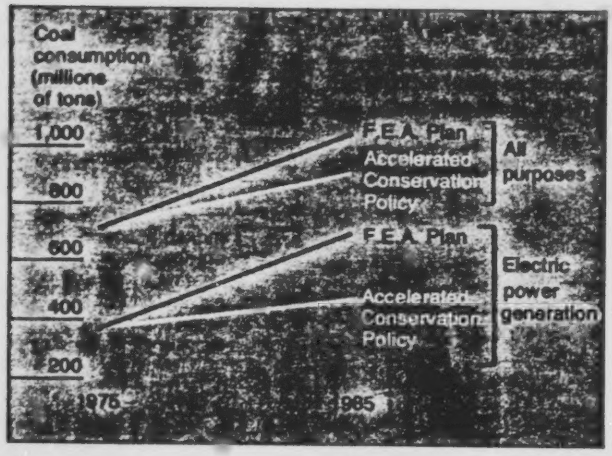
General Motors. The 1977 GM fleet average is projected to be 18.4 m.p.g. compared to 12.3 m.p.g. in 1974. Much of this improvement was accomplished through improved design and weight reduction, with little or no sacrifice in interior space or comfort. Planners should also consider a step-wise introduction of post-1980 standards, perhaps at a linear rate from 20 m.p.g. to the mandated 27.5 m.p.g. in 1985. This staged progression will insure that the improvements in average fuel economy continue without interruption for the turnover in overall population of 100-million-plus vehicles. The 27.5-m.p.g. goal is a difficult one, but there are strong indications that this level can be achieved by such strategies as the wider use of stratified charge or diesel engines, or both, improvement in transmissions, further weight reductions, etc. Some flexibility on the part of Congress with respect to emission levels of nitrogen oxides may be desirable to reach the optimum balance between fuel economy and exhaust pollutants.

Construct alternative electric generation capacity in lieu of 103,000 megawatts (Mw) of planned central station capacity. This alternative capacity would include cogeneration of electricity with industrial



process steam (64,000 Mw); generation by district plants producing both electricity and space heating for buildings (32,000 Mw); and burning trash to generate electricity (7,000 Mw). Together, these electricity sources would contribute 24.5 per cent of all U.S. electricity. To stimulate this substantial shift away from central station utilities to the far more efficient systems identified above, several actions will be required, such as mandatory rules for purchase of surplus industrial electricity by utilities; a restructuring of backup or demand charges originally designed by utilities to discourage on-site generation; provision of direct government loans to industries and apartment or commercial complexes to finance investments in on-site generating capacity; special taxes on industries and commercial businesses which do not take advantage of proven cogeneration opportunities; and changes in federal, state and local rules regulating utilities.

Establish efficiency goals for all energy-intensive industrial processing equipment and systems; examples are blast furnaces, paper-making machines, refinery and chemical plants, heat-treating equipment,



Coal consumption under the conservation policy would not rise nearly as precipitously as under the F.E.A. plan.

etc. In setting such goals consideration should be given to the efficiencies being attained in foreign countries where conservation technology has progressed further than in the United States.

Enact mandatory heating, insulation, and lighting standards for new residential and commercial construction. Standards should provide for optimum utilization of passive solar measures such as window and roof overhang design. We might also prohibit certain practices such as electric resistance space heating, and limit heat pump electric heating to those regions having moderate winter temperatures.

Enact progressively stricter efficiency standards for all major energy consuming appliances, such as water heaters, refrigerators, air conditioners, home furnaces, etc.

Phase out natural gas as a fuel, either for central station electricity generation or for process steam applications in industry. This could mean either a direct ban on such use, or a steeply progressive tax on gas fuel that is so misused. Sufficient gas must be reserved for residential space heating and for direct-fired high-temperature industrial processes to avoid excessive growth in electricity demand.

Provide direct government loans and other economic incentives to finance the retrofitting of houses with conservation equipment, including insulation, storm windows, improved furnaces, and other cost-effective systems. This program should be continued until every structure in the nation has been modified to an extent commensurate with the capital cost of incremental new energy supply. These measures probably won't be completed until well beyond 1985, and our projections assumed less than one Quad of savings per year.

Collectively, these and several less important actions would reduce energy consumption over the next decade to 80 Quads per year, a saving of 21 Quads relative to the F.E.A. plan. In effect, energy growth can be almost halted over the ten-year span while economic activity can still expand by 3 per cent per year. Moreover, the costly electrical sector would increase to only 2.53 trillion Kwh, a growth rate of 2.8

per cent per year relative to 1975. The fraction of total energy converted to electricity, 29 per cent, is higher than in 1975, but still well below the 34 per cent figure projected by the F.E.A. plan.

In the Accelerated Conservation Policy, distribution of energy by end-use sector differs from that if the F.E.A. plan, with transportation accounting for only 20 per cent, and industry rising slightly to 42 per cent. Sources of energy would change somewhat with nuclear fuel contributing only 7 per cent instead of 10 per cent of all energy. The fraction for oil and gas is about the same for both plans—63 per cent—but the contribution of coal rises from 22 per cent to 24 per cent under the accelerated conservation alternative.

Major contributions to the 21 Quads of total energy saved under the conservation policy are due to:

Automobile fuel economy standards (5.6 Quads),
Alternative methods for electricity generation (2.9 Quads),
Improved efficiencies in industrial processes (4.5 Quads), and
Appliance efficiency standards (2.5 Quads).

The remaining 5.5 Quads of savings result from improved insulation standards for all new buildings, increased retrofitting of insulation in existing structures, some modest usage of solar-assisted water and space heating, and greater efficiency in trucks due to wider use of diesel engines, improved scheduling practices, drag reductions, etc.

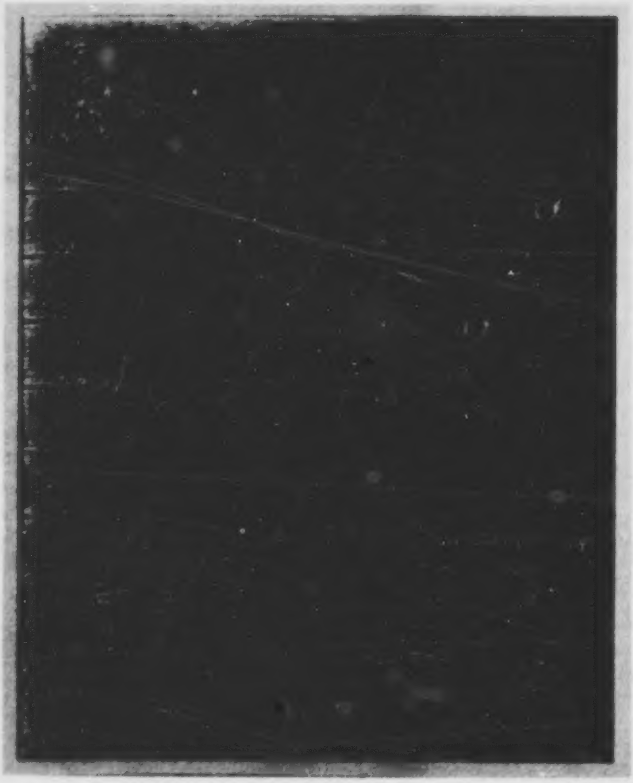
None of the measures we've proposed, except for far-term automobile efficiency improvements, requires unproven technology. Moreover, the overall improvement represents only a modest aggregate gain in the absolute efficiency of devices and processes. In fact, under our policy the average efficiency of energy utilization increases to 10.9 per cent—only 2.6 percentage points over the 8.3 per cent we mentioned earlier. Approximately one-third of this gain is attributabel to automobile fuel economy improvements alone.

WHAT COST CONSERVATION?

The most striking difference between the Accelerated Conservation Policy and the F.E.A. plan is the amount of capital needed to implement these alternative programs. Over the 1975-to-1985 decade the F.E.A. plan would require $570 billion for energy supply and $78 billion for energy conservation, for a total investment of $648 billion. In sharp contrast, the Accelerated Conservation Policy would require $61 billion for supply and $157 billion for conservation, for a total of only $218 billion—*less than half the F.E.A. capital requirements.*

These enormous capital savings are due in large part to sharply lower central station electric generating capacity. Less generating capacity investment is needed, not only because of reduced total electrical demand, but also because of the lower cost of alternative combined-cycle generating equipment, such as cogeneration. The conservation policy will thus result in significant savings on nuclear and fossil generating plant construction, and on coal, oil and gas consumption.

Savings on petroleum consumption will have a dramatic effect on imports. Accelerated conservation policies produce a net surplus or reserve of 4.5 Quads per year of natural gas by the end of the decade



Because of the slower growth of electrical demand, capital investment requirements for generation capacity, transmission and distribution, and fuel production facilities will be far less.

as is shown by comparisons of F.E.A. projections of maximum natural gas supply with our calculations of demand under a conservation policy. Required petroleum imports will be only 5.3 Quads or 2.4 million barrels per day—about one-third the present level of imports. Even if natural gas price controls were continued, the Accelerated Conservation Policy would curtail usage enough to almost exactly balance F.E.A.'s domestic supply forecast of 17.9 Quads for price-controlled supply. In contrast, the previous F.E.A. plan with complete price deregulation achieves zero imports in natural gas, but still requires the import of about 6 million barrels per day of petroleum—over 13 Quads.

There are clear and compelling economic advantages to the nation for conserving more energy. Before this can occur, however, we must resolve the differences between two different sets of economic assessments that ultimately determine how we balance energy conservation. The problem is that investment decisions on conservation are generally made by a completely different group than that responsible for

The greatest dividends of an Accelerated Conservation Policy occur because of sharply reduced oil and gas demand. In effect, accelerated conservation measures become the second most important energy source in 1985.

capital investments in energy supply. These two groups operate under substantially different ground rules for return-on-investment and access to capital markets. For example, the return-on-investment for energy conserving equipment required by energy users in industry is much higher than that for electricity plants achieved by regulated utilities, and the debt-to-equity ratio of manufacturing industries is much lower than that of utilities. Thus, it is totally unrealistic to suppose that the so-called "free market" approach will produce an optimal allocation of the nation's scarce capital resources among energy supply and conservation options.

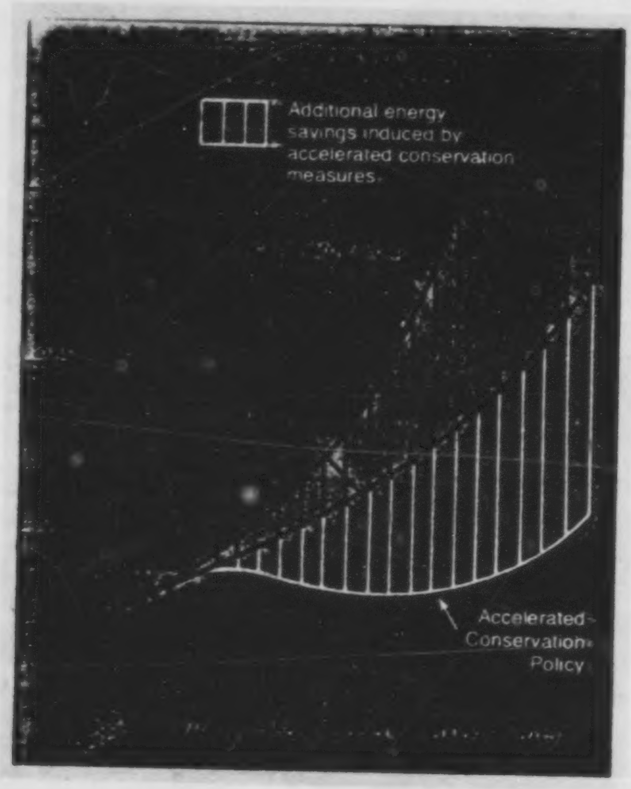
Nothing resembling a free marketplace exists today, given the fact of cartel pricing for petroleum, and considering the long history of massive federal subsidies to the energy supply industry—research and development grants, depletion allowances, guaranteed return on utility investments, etc. This fact has often been obscured by those who promote price deregulation as the only means for a comprehensive energy policy.

STRONG REGULATION NEEDED

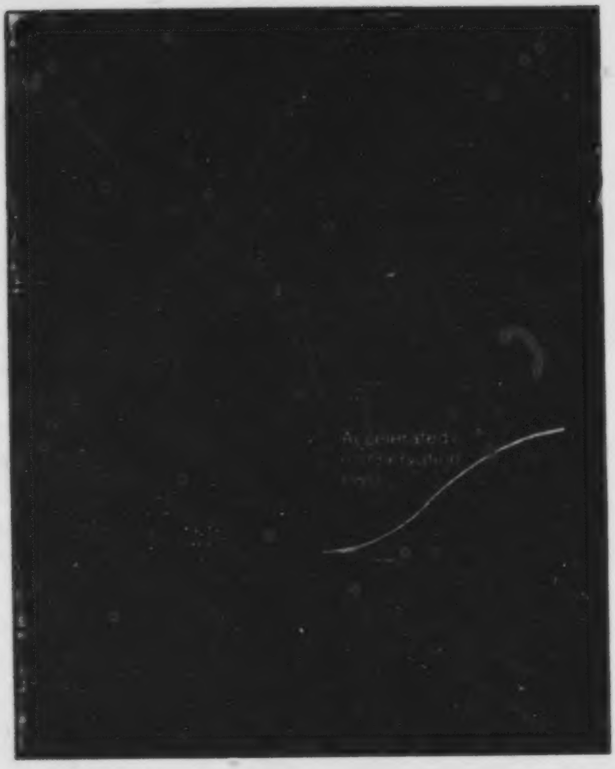
Our proposed policy for accelerated energy conservation depends heavily upon mandatory measures to improve end-use efficiency. This approach will inevitably raise arguments against tampering with the so-called "free market." Direct intervention must be considered, however, because price alone cannot provide sufficiently strong motivation for accelerated conservation.

Price increases are limited as a conservation stimulus even for the industrial sector, because energy cost still averages well below 10 percent of value added for all manufacturing. Thus, even large additional rises in fuel prices will not necessarily place overwhelming conservation pressures upon manufacturers.

Congress has recognized this aspect of energy policy, and has acted wisely in passing the mandatory automobile fuel economy legislation. By forcing the desired trend in new car efficiency, this measure will mean a continuing reduction in gasoline consumption throughout the



An Accelerated Conservation Policy which increased energy efficiency in our society by only about one percentage point every two-and-a-half years could allow an uninterrupted growth of three per cent per year in G.N.P., with little or no increase in energy demand.



An enormous untapped potential for conservation, discovered as we proceed along the conservation road, could well allow continued economic growth with no more energy than we use today. The efficiency improvements proposed by the authors may seem ambitious, but they are still less than those accomplished in the electric power industry.

next decade and beyond. Moreover, the law can reduce gasoline consumption without the need for decontrolled gasoline prices.

The transition to a conservation plan requires nothing short of a massive restructuring of the priorities for deployment of resources, both capital and technological. This shift must take place in a relatively short period so that we won't exhaust resources in marginal ventures.

ONLY THE BEGINNING FOR CONSERVATION

A conservation strategy could actually have more profound far-term implications than near-term. Current technology can clearly provide the 21 Quads of incremental annual savings over the next eight to ten years. But considering that overall second-law fuel efficiency would still be less than 11 percent at that point, aggressive research into end-use efficiencies could almost certainly advance the technology still further. A concerted effort in this area has not even begun, and the untapped potential for improvement may well exceed anything on the horizon among the various alternative energy supply options. If, for example, we were able to continue improving energy efficiencies by about one percentage point every two and a half years, we could sustain an uninterrupted growth in real G.N.P. of 3 percent per year for the next three decades, and still consume no more energy than we do today. Even then, our overall end-use efficiency would be only 20 percent, about equal to that of the steelmaking process today.

The improvements in energy end-use efficiency that we postulate are, in fact, not all that remarkable. As you can see from the graph above, they are still less than that accomplished over a comparable number of decades in improving electric generating plant efficiencies. The latter process, of course, has been subjected to enormous and continuing commitments of technological resources—the same prescription that is suggested here for energy end-use processes.

Some progress has already been made in overcoming the notion that the conservation of energy is synonymous with decreased economic activity. There is a growing awareness that capital investments in energy-saving devices can often yield greater dividends than comparable investments in new supply. Given appropriate stimulus, then, it is quite likely that the U.S. economy will make substantial progress toward more efficient end-use of energy over the next ten years. Unfortunately, there is little appreciation of the fact that conservation can play a major role in our long-term energy future. This misconception must be changed so that we can focus attention upon the task of developing the new conservation technology needed to insure continuing reductions in energy consumption in the period beyond 1985.

Perhaps the most decisive of all arguments in favor of conservation is the dividend that such a policy can buy in terms of time—the time needed for a thorough, searching, and balanced investigation of all possible energy supply alternatives, including the complete costs of their environmental and safety impacts.

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B. An Example of Competing Economic and Social Goals

[From Urban Transportation and Energy: The Potential Savings of Different Modes, pp. 41–54, xv.][*]

CHAPTER V: CONCLUSION

. . . A balanced and realistic assessment of energy conservation in urban transportation operations requires consideration of a wide range of technological, operational, and behavioral factors. Almost all these factors are marked by considerable variation from city to city, from one time of day to another, and from route to route. Any conclusions about the energy efficiency of transportation modes, or about the conservation potential of transportation programs, must be viewed as rules with numerous exceptions. Nevertheless, the rules that emerge from examination of existing technical information differ sharply from the normally accepted rules, and they are worth noting even if they are not universally true.

Long-term energy savings are particularly uncertain because, over a period of many years, there will be shifts in the locations of jobs, stores, and houses. These shifts will occur because urban growth is influenced by zoning policies, land costs, real estate tax differentials, quality of public schools, availability of parking, and myriad other such factors. The quality of available transportation is one of the forces shaping urban development, albeit a force that is notoriously difficult to isolate. Nevertheless, any shift in transport policy that facilitates long-distance travel may direct growth so as to create more such travel, and any policy that makes it easier to move in congested central parts of cities may lead to more concentrated growth and correspondingly shorter trips. Thus, insofar as expansion of vanpooling or express bus service leads to longer trips, the energy savings per passenger-mile of these modes may be offset somewhat by increases in miles traveled, while the opposite may hold true for rapid rail, light rail, or personal rapid transit systems that serve downtown areas.

Because urban growth depends on so many factors, the influence of transportation programs per se is difficult to quantify. The largest new public transportation project completed in recent years is San Francisco's BART system, and experience to date does not suggest that any significant shifts in metropolitan development have occurred there.[1] None of the changes in bus, vanpool, or carpool programs discussed here would involve anywhere near the level of public financial support that BART did, and the impacts of such change on urban development would probably not be any more noticeable. Nevertheless, the effects that changes in transportation policy have on metropolitan development patterns are poorly documented, and it should be noted that no developmental effects have been taken into account in making the estimates presented here.

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[*] Written and Published by the Congressional Budget Office, U.S. Congress, December 1977. Originally appeared as a committee print of the Senate Committee on Environment and Public Works, September 1977.

[1] There is some speculation that the BART system may encourage more sprawl than concentration, although this concern has little hard evidence to support it. See Henry Bain, "New Directions for METRO: Lessons from the BART Experience," The Washington Center for Metropolitan Studies (December 1976), p. 22; and Melvin M. Webber, "The BART Experience—What Have We Learned?" *The Public Interest*, No. 24 (Fall 1976).

In this context, the remainder of this section summarizes CBO's principal findings regarding energy conservation in urban transportation and some of their implications for design of the federal mass transit program.

Vanpools

Of all the urban transport modes, vanpools can probably make the greatest contribution to energy savings on a per-passenger-mile basis. The chief advantage of vanpools lies, not in their technology, which is essentially that of conventional light trucks, but in the exceptionally high load factors that characterize existing vanpool operations. Indeed, if any of the other urban transportation modes could operate as near to seating capacity as do vanpools, their fuel conservation potential would be equally impressive.[2] This is unlikely, however, because none of the other public modes operate in the peak-hour-only, single direction, prearranged fashion that is characteristic of vanpools, and it is very difficult to maintain near-capacity loads in the absence of these features. Thus, the superior energy efficiency of vanpools, on a per-passenger-mile basis, is not apt to be challenged. Rather, the conservation potential of vanpools and carpools will probably increase relative to that of other public modes in future years since improvements in the fuel economy of light trucks (and hence of vanpools) are anticipated to be large compared to those of other forms of public transportation.

In spite of the clear advantages of vanpools on a per-passenger-mile basis, the contribution of vanpooling programs to national fuel conservation remains limited because of the very special conditions under which successful vanpools operate. Existing vanpool programs typically operate between relatively dense concentrations of homes and a common, distant workplace. Roundtrips of 40 to 100 miles are common among vanpools, although some operate over considerably shorter routes.[3] Because of the long trip lengths characteristic of vanpools, the potential market for this service represents a small fraction of the nation's work trips. Thus, even though vanpool programs will probably not lead to large fuel savings at the national level, they provide one of the potentially most productive parts of any program directed at urban transport energy in general.

Furthermore, vanpool programs now in existence indicate that this mode can be largely self-supporting and that massive federal assistance is not needed to start or maintain vanpools. Currently, the spread of such systems is severely impeded by state and federal regulations imposed by state public utility commissions, the Interstate Commerce Commission, the Bureau of Motor Carrier Safety, and various labor laws. These regulations sometimes discourage companies from getting involved in vanpooling and sometimes prevent several employers from getting together to start or extend vanpool service.

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[2] Two reasons vanpools achieve such a high load factor are: first, the requirement that there be enough passengers to pay both capital and operating costs; second, the driver's financial incentive to keep the number of passengers at or near capacity.

[3] Gerald K. Miller and Melinda A. Green, "Guidelines for the Organization of Commuter Van Programs," Report prepared by the Urban Institute for the Urban Mass Transportation Administration, February 1976.

These regulatory constraints on vanpool expansion are probably the most fertile area for legislative action. In particular, the exemption from Interstate Commerce Commission and state regulation contained in the proposed National Energy Act[4] could be extended to apply to nonfederal vanpooling without damage to the existing public transportation services that these regulations are intended to protect.

In summary, vanpools can produce large fuel savings in special circumstances, although these circumstances apply to only a small segment of the overall travel market. Vanpool operations require little or no public financial support, and it does not appear that increased federal spending would be appropriate to spread the application of this energy-efficient mode. At present, state and federal regulations inhibit the expansion of vanpools, and these appear to be amenable to legislative action if the Congress elects to encourage this mode of transportation.

Buses

Of the conventional urban public transportation modes (subway, trolley, and bus), buses appear to offer the greatest promise in terms of energy conservation. Although typically the operating-energy intensity of buses is only slightly better than that of other conventional public transport modes, their modal energy is only about half that of new rail or trolley systems because of the access conditions and route coverage that generally characterize bus service. Furthermore, because express bus service can be designed to draw heavily from segments of the market that are now automobile-oriented, the energy savings of programs that promote new bus service are probably greater than programs aimed at any other public transport mode. That is, a new bus trip typically means greater energy savings than a new rapid rail, commuter rail, or trolley trip. Also, new bus services—even those requiring exclusive rights-of-way—tend to be less expensive ways to draw new patronage than these other modes.

Current federal programs provide extensive support for capital costs of transit systems on an 80 to 20 matching basis. Although private bus service provides are not eligible for this support, the overall level of capital cost support for buses does not appear to be a major problem, at least as far as existing capital programs go.

Probably the greatest constraint to expansion of energy-efficient bus service is operating costs. Operating deficits have risen at an alarming rate in recent years, and both federal and local governments are cautious about taking any steps that might aggravate this problem. Under

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[4] "Neither the offering of a vanpooling arrangement pursuant to this subsection nor the operation of a van pursuant to such an arrangement shall subject any person to regulation as a motor carrier under part II of the Interstate Commerce Act (49 U.S.C., 301 et seq.) or to any similar regulation under the laws of the District of Columbia or of any State or political subdivision thereof." (H.R. 8444, section 701, subsection c6).

Section 5 of the Urban Mass Transportation Act of 1964, the Urban Mass Transportation Administration provides up to 50 percent of the transit operating deficit. These funds, however, are allocated among urban areas on a formula basis and generally cover substantially less than half of the operating losses in larger metropolitan areas. Many observers fear that increases in the federal money for this purpose would lead to more inefficient operations, and it is not clear that expansion of Section 5 support would be appropriate as part of an energy conservation program. Because bus operating costs are overwhelmingly labor costs, attempts to curb costs may immediately run counter to employment goals, and there appear to be no simple ways to make substantial cost cuts that are acceptable to all parties involved.

Nevertheless, some of the innovative bus services—particularly, subscription service such as the Reston Express bus outside Washington, D.C.; Specialty Transit in St. Louis, Missouri; and COM-BUS in Los Angeles, California—have shown that additional bus service can be operated at little or no expense to the public.[5] The growth of this service appears to be limited by local regulations that protect existing operators and by the concerns of labor (many peak-hour-only services are most efficiently run using part-time help).

By their nature, subscription buses usually provide private, peak-hour-only service. The primary need of this type of service is not federal financial support, but exemption from the institutional obstacles that limit its growth. If the Congress wishes to provide financial assistance to promote this service, its efforts would best be placed, not in existing capital or operating subsidy programs, but in programs that relax local regulations by creating job security. That is, federal underwriting of existing transit jobs or services could give localities the assurance that they need to experiment with innovative supplements to existing bus service.

Giving buses priority in traffic through special traffic signaling or reservation of lanes, and giving buses (along with carpools, vanpools, and other energy-efficient modes) exclusive right-of-way can also greatly enhance the attractiveness and patronage of the service. Existing federal programs provide for capital support of these services,[6] but in many situations the changes required to implement bus priority schemes require relatively little capital expenditure, and federal assistance offers little incentive to local officials. Exclusive right-of-ways for buses, such as those on the Shirley Highway outside Washington, D.C., are more capital-intensive than other bus priority measures, and they do not have the adverse effects on automobile traffic that separating off an existing lane for bus use implies. A more aggressive federal program in the area of acquiring and constructing exclusive right-of-ways could be a productive way to promote the energy-saving advantages of bus service. Such a program could be broadly interpreted to include relocating on-street parking to off-street which would yield additional capacity from existing facilities, and constructing bridges, by-passes, and other facilities to enhance the movement of high-occupancy vehicles. Local conditions are too diverse to attempt to specify such a program in detail, but designating additional money for Urban Mass Transportation Administration Section 3 funds for this purpose could be a fruitful approach. Additional incentives could be provided if separate federal operating assistance over and above the existing operating aid program were available for those specific projects with a relatively high potential for saving energy. As with the current aid program, the federal share of operating losses should probably be held to a maximum of 50 percent, to ensure some incentives for efficient local operations.

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[5] Ronald N. Kirby et al., *Para-Transit: Neglected Options for Urban Mobility* (The Urban Institute, 1974).

[6] Many of these projects are classified as Transportation System Management (TSM) by the Urban Mass Transportation Administration and are funded with capital grants (Section 3) or, in some cases, demonstration grants. Some Federal Highway Administration funds (primarily money for urban systems) can also be used for these purposes.

Carpools

Carpools can make a significant contribution to energy conservation. A typical mile of travel diverted to carpool saves more energy than does diversion to any other mode except vanpool, according to the results shown in Table 9. Unlike vanpools, for which the potential market is very small, carpools could potentially be used for a large portion of all commuter travel. It is not clear, however, to what extent additional spending can increase carpooling. Promotion programs that locate and match potential carpoolers are relatively inexpensive, but they produce modest gains at best. Incentives such as free parking, or permission to use reserved right-of-ways along with other high-occupancy vehicles are promising ways to use federal funding to promote carpools.

Dial-a-Ride

From the standpoint of energy conservation, dial-a-ride service appears to be counterproductive. Because of low load factors and high route circuity, dial-a-ride is an energy-wasteful mode by almost any measure. This service, however, has some unique advantages in being of use to the handicapped and the elderly, and its energy costs must be weighed against its social contributions.

Light Rail Transit

Although much attention has been given to light rail transit in recent discussions, the energy properties of this mode are generally comparable to those of heavy rail transit, except for some savings in construction energy and station and maintenance energy. In terms of the estimates shown in Table 9, these advantages are sufficient to make light rail transit marginally effective in conserving energy, although it appears to rank significantly lower than bus, vanpool, or carpool in terms of its conservation potential.

Automobiles

Automobiles are generally the least energy-efficient of the urban transportation modes. The figures in Table 9 show that automobiles currently require about twice as much energy per passenger-mile as do new rail rapid transit systems. Some of the differences apparent in a comparison of line-haul energy requirements become modified, however, when the access and circuity of fixed-route modes are taken into account. Moreover, the gap between the automobile's energy requirements and those of other modes will shrink even further as the fuel economy standards for new cars set out in the Energy Policy and Conservation Act and the additional automotive fuel economy measures now being considered by the Congress start to increase the average fuel economy of the nation's automobile fleet.

Even though earlier analysis by the Congressional Budget Office indicates that the 1985 fuel economy standard of 27.5 miles per gallon is unlikely to be met, average new car fuel economy (combined city and highway cycles) is nonetheless expected to jump from 17.8 miles per gallon in 1977 to 23.3 miles per gallon in 1985, and the automobile fleet as a whole will probably average more than 23 miles per gallon by 1990.[7] Comparable fuel efficiency gains are not anticipated for buses or rail systems. Thus by the time major extension to these services could be built, their fuel efficiency advantages, where they now exist, would be reduced by roughly 20 percent. Indeed, one study concludes that "with present power sources, the subways will lose their (operating) energy advantage over the automobile by the end of the century."[8]

Rapid Rail

Of all the commonly held notions about energy efficiency, probably the most misguided are those concerning rapid rail transit. The findings of the previous chapter indicate that under typical conditions, new rapid rail systems actually waste energy rather than save it. This surprising finding appears to conflict with the fact, that, in terms of operating energy per passenger-mile, rail ranks among the most energy-efficient of all modes. But when construction and station energy are considered as well, rapid rail ranks among the least energy-efficient of the conventional urban public transportation modes. Furthermore, when mode of access and circuity are included, the energy per productive mile computed over the entire trip is greater than that of all the other public modes except dial-a-ride. The principal reason for this poor performance is the considerable use of low-occupancy private automobiles to access new rapid transit stations. Finally, the average patron of mass transit systems is drawn from a mode in which energy efficiency is better than that for the rail system. This produces a small net loss of energy overall.

As noted earlier, exceptions to patterns such as this are probably not difficult to find. Slight variations in the judgments about exactly what constitutes typical conditions could lead to a revised set of computations in which the energy impact of rapid rail transit appears somewhat favorable. But, even though it is possible to argue about the precise value of all of the factors bearing on the energy intensiveness of rail rapid transit, these fine points of discussion have little to do with the substantive conclusion that rail rapid transit offers hardly any aid to the nation's efforts to save fuel. Indeed, even wildly optimistic assumptions about all aspects of rapid rail transit lead to the same conclusion.

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[7] Congressional Budget Office, *President Carter's Energy Proposals: A Perspective*, Staff Working Paper (June 1977). (The figures reported do not assume that any new car fuel economy regulations are in force other than those contained in the Energy Policy and Conservation Act.)

[8] Regional Plan Association, "Power for the MTA," June 1977, p. 4. Subways would still play a significant role in energy conservation since they permit New York City and other large eastern cities to maintain their energy-efficient, high-density nature.

For the purposes of illustration, consider a program recently proposed in the House of Representatives that would have used half of the revenues from a 5 cent per gallon tax on gasoline and diesel fuel to fund various transit programs.[9] Although it was never intended that these revenues would be devoted to new rail transit projects exclusively, for sake of illustration it is assumed here that they are. Over ten years, the revenues from a 2.5 cent gasoline tax would total about $28 billion. Based on the existing 80 : 20 matching ratio between federal and local funds, this leads to transit construction expenditures of $35 billion over ten years. Even at today's prices, this sum would buy fewer than six systems the size of Washington's proposed 98-mile Metro. Since the gasoline tax would be collected and spent in future years when the dollar will buy less than it does now, the gasoline tax revenues would probably not even support four Metro-like systems.

Nonetheless, assume that six Metro-like systems are built and that each of these systems is fully in use by 1990. Further, suppose that each of the six new systems carries 300 million trips per year. This is the number of trips that the promoters of the Metro system claim will ride Washington's subway in 1990. This figure has been attacked as being an unrealistically optimistic projection;[10] it represents about eight times as many passengers per year as San Francisco's 72-mile BART system now attracts.

Further, suppose that each of these new trips is five miles long and that each new transit trip replaces an auto trip of identical length. Again, these assumptions overstate the likely effects of transit since many new transit patrons would be former bus or carpool travelers, and thus would not diminish automobile traffic very much. Also, a great number of transit trips would still require use of a car to get to the station.

Finally, assume that cars in 1990 average 15 miles per gallon in urban traffic, and that rail transit systems require absolutely no energy to operate. Again, these assumptions favor rail transit. The energy savings of the $35 billion program would then be: 6 new rapid rail systems × 300 million trips per year per system × 5 miles per trip = 9 billion miles of automobile travel eliminated per year, assuming new transit trips replace automobile trips mile for mile. The associated fuel savings, in terms of the conventional measure of barrels per day, are: 9 billion miles of automobile travel ÷ 15 miles per gallon ÷ 42 gallons per barrel ÷ 365 days per year = 39,000 barrels per day, or 0.7 percent of 1976 daily consumption.

Thus, even under wildly optimistic assumptions, this $35 billion transit program would lead to 1990 fuel savings of fewer than 40,000 barrels of oil per day. If transit systems are assumed to have a life of 50 years, these savings are equivalent to a price of about $50 barrel of oil, versus the current world price of about $14.

Changing a few assumptions to more realistic values reduces the estimated fuel savings considerably. For example, assuming an average of 150 million persons per year (still four times the level of

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[9] *Congressional Record*, daily ed., July 29, 1977, pp. 8232–33.

[10] "Washington Area Metro Rail System: Perspective and Alternatives," Study and Report from the Library of Congress, Congressional Research Service, for the Subcommittee on Fiscal Affairs of the Committee on the District of Columbia, House of Representatives, Committee Print S–4, February 1976.

BART) leads to fuel savings of 20 thousand barrels per day in 1990. Similarly, more realistic assumptions about the rate of which automobile trips are displaced, about inflation and the likely costs of future heavy rail systems, about future automotive fuel efficiency, and about transit fuel efficiency can be shown to lead to substantially lower fuel savings.

In view of the limited energy conservation potential of rail rapid transit and the enormous capital costs of such systems, expenditure of federal funds on these systems for purposes of energy conservation appears to be misguided and possibly even counterproductive.

MIDDLE ESTIMATES FOR VARIOUS MEASURES OF ENERGY REQUIRED BY URBAN TRANSPORTATION MODES

[All measures expressed in Btu's per passenger-mile]

Mode	Operating energy [2]	Modal energy [3]	Program energy [4]
Single-occupant automobile	11,000	14,220	(1)
Average automobile	7,860	10,160	(1)
Carpool	3,670	5,450	4,890
Vanpool	1,560	2,420	7,720
Dial-a-Ride	9,690	17,230	(12,350)
Heavy rail transit (old)	2,540	3,990	(1)
Heavy rail transit (new)	3,570	6,580	(980)
Commuter rail	2,625	5,020	970
Light rail transit	3,750	5,060	30
Bus	2,610	3,070	[5] 3,590

[1] Not applicable.

[2] Propulsion only.

[3] All forms of energy, computed on a door-to-door basis, adjusted for roundabout journeys.

[4] Energy saved (lost) per passenger-mile of travel induced by new programs.

[5] For new express bus service; regular urban bus service would show smaller savings.

[From Hearing held October 5, 1977, before the Senate Subcommittee on Transportation on the Congressional Budget Office Report "Urban Transportation and Energy: The Potential Savings of Different Modes," p. 134–137, 182–186, and printed for use of the Senate Committee on Environment and Public Works.]

A. Excerpt From Comments Prepared by the Metropolitan Atlanta Rapid Transit Authority

The paper "Urban Transportation and Energy: The Potential Savings of Different Modes", prepared by the Congressional Budget Office in September, 1977 concludes, among other things, that "new rail rapid transit systems actually waste energy rather than save it" and that: "In view of the limited energy conservation potential of rail rapid transit and the enormous capital costs of such systems, expenditure of federal funds on these systems for purposes of energy conservation appears to be misguided and possibly even counter productive."

This finding, admittedly surprising in view of its contradiction on conventional wisdom as the CBO researchers themselves point out, is arrived at after a comparison of the aggregate measures of energy use of alternative urban transport modes, leading to an estimate of the energy that would be conserved (or wasted) by switching from certain modes (including the private automobile) to others such as rail rapid transit and buses.

This paper contains serveral erroneous assumptions and generalizations in its handling of the data, which if corrected could well lead to totally different conclusions. These will be discussed in detail below. However, the study's major shortcoming is the fundamental premise on which it is based; that is, it analyzes relative energy intensiveness of the different urban transportation modes *regardless of source.* In the analysis, the energy consumption of the different modes is converted to a common unit (British Thermal Units or BTU's). No reference is found anywhere in the report, however, to the fact that all energy consumed by road-oriented public or private transportation (cars, carpools, van pools and buses) is generated from petroleum products, whereas rail public transportation is unique in that electrically powered vehicles operate on electricity which is (or can be) produced entirely from coal and other non-petroleum sources.

Any one who is even remotely aware of the so-called "energy crisis" is fully cognizant that this situation originates not from a scarcity of all sources of energy, but from the fact that the United States economy has come to depend heavily on a specific source of energy, petroleum, the domestic availability of which is rapidly being depleted, and that as a result the United States has come to depend largely on foreign suppliers for its oil. This dependency has created a seriously deteriorating balance of payments problem for this country, and potentially a precarious situation in which the economy of the United States could be "shut off" at will overnight by political factors beyond the control of this nation.

President Carter's energy message clearly points out the fundamental nature of the energy crisis:

> The heart of our energy problem is that our demand for fuel keeps rising more quickly than our production, and our primary means of solving this problem is to reduce waste and inefficiency.
>
> Oil and natural gas make up 75 percent of our consumption in this country, but they represent only about 7 per cent of our reserves. Our demand for oil has been rising by more than 5 per cent each year, but domestic oil production has been falling lately by more than 6 per cent. Our imports of oil have risen sharply—making us more vulnerable if supplies are interrupted—but early in the 1980's even foreign oil will become increasingly scarce. If it were possible for world demand to continue rising during the 1980's at the present rate of 5 per cent a year, we could use up all the proven reserves of oil in the entire world by the end of the next decade.

Accordingly, the principles behind the President's plan and goals for 1985 call for a reduction in the consumption of petroleum-generated energy and a *shift* to other forms of sources energy, primarily coal and eventually solar energy. Specifically these goals are:

To reduce the annual growth rate in our energy demand to less than 2 per cent;

To reduce gasoline consumption by 10 per cent;

To cut imports of foreign oil to 6 million barrels a day, less than half the level it would be if we did not conserve;

To establish a strategic petroleum reserve of one billion barrels, about 10 months' supply;

To increase our coal production by more than two-thirds, to over one billion tons a year;

To insulate 90 per cent of American homes and all new buildings; and

To use solar energy in more than 2½ million homes.

It is inconceivable how the Congressional Budget Office could have completely ignored the heart of the energy problem in analyzing energy intensiveness of different urban transport modes. The United States consumes about 18 million barrels of oil per day. Of this more than 50 per cent is for transportation. Highway vehicles consume 80 per cent of that petroleum, and the private automobile uses 71 per cent of that share. In other words, the private automobile uses up to 34 per cent of the total amount of petroleum consumed in the United States. The CBO report does not even allude to these facts and instead, in its very introduction the CBO report states:

> However, energy is not of primary importance to transportation: less than 20 percent of the costs of owning and operating a car are traceable to gasoline and less than 5 percent of the costs of urban public transportation are related to fuel. Thus, from the vantage point of the provider of transport service, costs other than fuel costs (for example vehicle purchase costs, labor costs, repair costs, etc.) tend to be largest, thus relegating fuel costs to a position of secondary importance.

True, but are we actually dealing with the *costs* of energy as a component of transportation's total costs? Or are we talking about conserving a depleting resource regardless of its present, artificially low, price to the user. Does the present price of gasoline reflect the impending scarcity of this source of energy? Certainly the CBO would not suggest that the unavoidable shortage of petroleum will not be eventually reflected in the energy component of transportation costs. The statement above is illustrative of how the CBO has completely missed the point: *even assuming that urban rail transportation is more energy-intensive than highway-vehicle oriented transportation, rail transit can be powered by an energy source that does not use any petroleum.*

B. Excerpt From Comments Prepared by the Regional Transportation Authority (Chicago)

. . . When the oil embargo of 1973 was in effect, *a series of quick and otherwise undistinguished computations* were carried out to see whether mass transit might be of some use in conserving energy. It was reasoned that if the nation used little oil during the years when mass transit flourished and automobiles were not yet in extensive use, then a return to a modern version of that condition would greatly reduce oil use. The overwhelming numbers of automobiles, well in excess of 100 million new and increasing every year, lead the analysts to conclude this argument was not realistic. There are simply too many cars in comparison to the 50,000 odd transit vehicles. It would take at least 15 years according to traditional calculations to develop enough public transportation nationwide to replace a significant portion of auto trips. This misunderstanding of the potential of transit to influence trips came from the simple arithmetic comparison of numbers, of assuming that trips are based purely on number of occupancy seats available.

To determine whether transit had any potential for alleviating the energy crisis, analysts began carrying out detailed theoretical calculations. Unfortunately, *the only data available*, giving relative efficiencies of bus engines as compared to car engines for example, limited analysis to an established procedure of computing relative efficiencies of transit vehicles versus automobiles. Thus a bus and a car traveling side by side on an expressway could be directly compared to see which used less energy. Electric rapid transit posed a special difficulty since gasoline is not used and a conversion must be made based on various assumptions to convert kilowatts to some "equivalent" gallons per mile, a questionable approach at best.

Assumptions also had to be made about the number of people riding on a bus or car, and here a great dichotomy developed. At rush hour, transit is packed and the efficiency is very high; after rush hour, and especially after midnight, transit has few riders and is very inefficient. How can this be reconciled into a single number? There is no way to do this to produce a unique answer. Depending on how the averages are taken, any kind of efficiency can be computed. The hope was that somehow these computations for an individual bus or car would reflect total energy use patterns within the community.

Thus reports became long and involved, with any prescribed result being possible by simply juggling one or another of the complex assumptions. This unfortunate theoretical approach, so widely used, has led to more confused conclusions and blind alleys than would have been thought possible.

Reports of transit advocates thus contradicted reports of automobile advocates. A transit operation for example would point out that a large bus, with a rush hour load of 70 people, operating in at least a part-express type service generates (70 passengers) × (6 miles/gallon) = 420 passenger miles per gallon. A driver-alone compact car getting 20 miles per gallon would be achieving (20) × (1) = 20 passenger miles/gallon. For an automobile to compete with the bus at rush hour, it would need to achieve 420 miles per gallon.

Detractors of this computation complain that the bus must make a return trip, whereas the car does not, so that if the loading is less on the return trip, then some kind of average should be taken to reduce this value of 420. Advocates of transit point out this type of efficiency is achieved every day all over the country.

Comparative computations with electric rapid transit and commuter trains reveals an even deeper level of erratic reasoning. Proponents of transit like to point out that electric powered service does not operate on oil. Electricity can be generated from water, coal, nuclear or the chemicalization of garbage. In cities such as Seattle and San Francisco, all power is hydroelectric, generated at large dams. In Chicago, electric power is from combined coal and nuclear sources. Oil as a source of electrical power is fast disappearing in use and will continue to be used less as more coal is available.

Yet analysts persist in the notion that the kilowatts of power can be effectively replaced through engineering conversion to a meaningful "miles per gallon of gasoline" when in fact rapid transit systems use no gasoline. Then, by assuming very low load factors and using large average trip distances by gas guzzler cars to get to the transit station, analysts are able to so underestimate the efficiency of trains as to recommend that rails should be paved over and the passengers transferred to buses.

These convoluted arguments thus purport to show the Nation would be better off if people stopped using electrical energy to get to work and instead used buses; this leads to the non-sensical conclusion that the Nation *can reduce oil consumption by using more oil.* Legislators should not be surprised with polls showing American's faith in institutions to be on the decline.

These highly complex arguments are often bent toward other ends. If one agency or another wishes to inhibit construction programs for rapid transit, so that the money can be allocated to other needs, it can be easily arranged to produce a computer based document "proving" the point that transit does not save energy. A press release on nationwide television then announces such findings, as has happened, but fails to mention such things as the fine points of exchanging electrical for oil energy. It is an example of how easily technical problems lend themselves to misinterpretation by those who stand to gain from convoluted arguments.

Regardless of the details of these familiar techniques for computing transit efficiencies, all contain the same basic error in analysis: they neglect the feedback effect between automobiles and transit. Transit suppresses automobile use. This ability of transit to eliminate miles not by attracting auto users but simply by discouraging trips is in many cases more effective in saving energy than other considerations. The value of transit can not be determined from computing gasoline use requirements of individual vehicles. The true answers lie elsewhere. . . .

C. Soft versus Hard Paths: Amory Lovins *et al.*

ENERGY STRATEGY: THE ROAD NOT TAKEN?

(By Amory Lovins)*

2.1. OVERVIEW

Where are America's formal or de facto energy policies leading us? Where might we choose to go instead? How can we find out?

Addressing these questions can reveal deeper questions—and a few answers—that are easy to grasp, yet rich in insight and in international relevance. This chapter will seek to explore such basic concepts in energy strategy by outlining and contrasting two energy paths that the United States (or, by analogy, other countries) might follow over the next fifty years—long enough for the full implications of change to start to emerge. The first path resembles 1976–7 federal policy and is essentially an extrapolation of the recent past. It relies on rapid expansion of centralized high technologies to increase supplies of energy, especially in the form of electricity. The second path combines a prompt and serious commitment to efficient use of energy, rapid development of renewable energy sources matched in scale and in energy quality to end use needs, and special transitional fossil fuel technologies. This path, a whole greater than the sum of its parts, diverges radically from incremental past practices to pursue long-term goals. It does not try to wipe the slate clean, but rather to redirect our future efforts, taking advantage of the big energy systems we already have without multiplying them further.

Both paths, as will be argued, present difficult—but very different—problems. The first path is convincingly familiar, but the economic and sociopolitical problems lying ahead loom large, and eventually, perhaps, will prove insuperable. The second path, though it represents a shift in direction, offers many social, economic, and geopolitical advantages, including virtual elimination of nuclear proliferation from the world. It is important to recognize that the two paths are mutually exclusive. Because commitments to the first may foreclose the second, we must soon choose one or the other—before failure to stop nuclear proliferation has foreclosed both.[1]

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[1] In this chapter the proportions assigned to the components of the two paths are only indicative and illustrative. More exact computations, now being done by several groups in the United States and abroad, involve a level of technical detail which, though an essential next step, may deflect attention from fundamental concepts. This chapter will accordingly seek technical realism without rigorous precision or completeness. See Chapter Three for methodological discussion. Further technical details are given in later chapters and their citations. See also the independent but somewhat related analysis to be published in 1977 by the Union of Concerned Scientists (1208 Massachusetts Avenue, Cambridge, Massachusetts 02138) as the report of the UCS Energy Study.

2.2. HARD ENERGY PATHS

Most official proposals for future U.S. energy policy embody the twin goals of sustaining growth in energy consumption (assumed to be closely and causally linked to GNP and to social welfare) and of minimizing oil imports. The usual proposed solution is rapid expansion of three sectors: coal (mainly strip-mined, then made into electricity and synthetic fluid fuels); oil and gas (increasingly from Arctic and offshore wells); and nuclear fission (eventually in fast breeder reactors). All domestic resources, even naval oil reserves, are squeezed hard—in a policy that David Brower calls "Strength Through Exhaustion." Conservation, usually induced by price rather than by policy, is conceded to be necessary but it is given a priority more rhetorical than real. "Unconventional" energy supply is relegated to a minor role, its significant contribution postponed until past 2000. Emphasis is overwhelmingly on the short term. Long-term sustainability is vaguely assumed to be ensured by some eventual combination of fission breeders, fusion breeders, and solar electricity. Meanwhile, aggressive subsidies and regulations are used to hold down energy prices well below economic and prevailing international levels so that growth will not be seriously constrained.

Even over the first ten years (1976–1985), the supply enterprise typically proposed in such projections is impressive. Oil and gas extraction shift dramatically to offshore and Alaskan sources, with nearly 900 new oil wells offshore of the contiguous forty-eight states alone. Some 170 new coals mines open, extracting about 200 million tons per year each from eastern underground and strip mines, plus 120 million from western stripping. The nuclear fuel cycle requires over one hundred new uranium mines, a new enrichment plant, some forty fuel fabrication plants, three fuel reprocessing plants. The electrical supply system, more than doubling, draws on some 180 new 800 megawatt coal fired stations, over one hundred forty 1000 megawatt nuclear reactors, sixty conventional and over one hundred pumped storage hydroelectric plants, and over 350 gas turbines. Work begins on new industries to make synthetic fuels from coal and oil shale. At peak, just building (not operating) all these new facilities directly requires nearly 100,000 engineers, over 420,000 craftspeople, and over 140,000 laborers. Total indirect labor requirements are twice as great.[2]

This ten year spurt is only the beginning. The year 2000 finds us with 450 to 800 reactors (including perhaps eighty fast breeders, each loaded with 2.5 metric tons of plutonium), 500 to 800 huge coal-fired power stations, 1000 to 1600 new coal mines and some fifteen million electric automobiles. Massive electrification—"the most important attempt to modify the infrastructure of industrial society since the railroad"[3]—is largely responsible for the release of waste heat sufficient in principle to warm the entire freshwater runoff of the contiguous forty-eight states by 34–49° F.[4] Mining coal and uranium, increasingly in the arid West, entails inverting thousands of communities and millions of acres, often with little hope of effective restoration. The commitment to a long-term coal economy many times the scale of today's makes the doubling of atmospheric carbon dioxide concentration early in the next century virtually unavoidable, with the prospect then or soon thereafter of substantial and perhaps irreversible changes in global climate.[5] Only the exact date of such changes is in question.

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[2] The foregoing data are from M. Carasso et al., *The Energy Supply Planning Model*, PB–245 382 and PB–245 383 (Springfield, Virginia: National Technical Information Service, Bechtel Corp. report to the National Science Foundation (NSF), August 1975). The figures assume the production goals of the 1975 State of the Union Message. Indirect labor requirements are calculated by C. W. Bullard and D. A. Pilati, CAC Document 178 (September 1975), Center for Advanced Computation, University of Illinois at Urbana-Champaign. See Chapter 1.2.

[3] I. C. Bupp and R. Treitel, "The Economics of Nuclear Power: De Omnibus Dubitandum," 1976 (available from Professor Bupp, Harvard Business School).

The main ingredients of such an energy future are roughly sketched in Figures 2–1. For the period up to 2000, this sketch is a composite of recent projections published by the Energy Research and Development Administration (ERDA), Federal Energy Administration (FEA), Department of the Interior, Exxon, and Edison Electric Institute. Minor and relatively constant sources, such as hydroelectricity, are omitted; the nuclear component represents nuclear heat, which is roughly three times the resulting nuclear electric output; fuel imports are aggregated with domestic production. Beyond 2000, the usual cutoff date of present projections, the picture has been extrapolated to the year 2025—exactly how is not important here—in order to show its long-term implications more clearly.[6]

2.3. WHY HARD PATHS FAIL

The flaws in this type of energy policy have been pointed out by critics in and out of government. For example, despite the intensive electrification—consuming more than half the total fuel input in 2000 and more thereafter—we are still short of gaseous and liquid fuels, acutely so from the 1980s on, because of slow and incomplete substitution of electricity for the two-thirds of fuel use that is now direct. Despite enhanced recovery of resources in the ground, shortages steadily deepen in natural gas—on which plastics and nitrogen fertilizers depend—and, later, in liquid fuel for the transport sector (half our oil now runs cars). Worse, at least half the energy growth never reaches the consumer because it is lost earlier in elaborate conversions in an increasingly inefficient fuel chain dominated by electricity generation (which wastes about two-thirds of the fuel) and coal conversion (which wastes about one-third). Thus in Britain since 1900, primary energy—the input to the fuel chain—has doubled while energy at the point of end use—the car, furnace, or machine whose function it fuels—has increased by only a half, or by a third per capita; the other half of the growth went to fuel the fuel industries, which are the largest energy consumers.

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[4] Computation concerning waste heat and projections to 2000 are based on data in the 1975 Energy Research and Development Administration Plan (ERDA–48).

[5] B. Bolin, "Energy and Climate," Secretariat for Future Studies (Fack, S–103 10 Stockholm); S. H. Schr[illegible]ler and R. D. Dennett, *Ambio* 4, 2:65–74 (1975); S. H. Schneider, *The Genesis Strategy* ([illegible]w York: Plenum, 1976); W. W. Kellogg and S. H. Schneider, *Science* 186:1163–72 (197[illegible]; S. H. Schneider, *J. Atmos. Sci.* 32:2060–66 (1975); W. W. Kellogg, "Effects of Human [illegible]ctivities on Global Climate," (Geneva: World Meterological Organization, Octo'er 1976 [illegible]nd "Global Influences of Mankind on the Climate," in J. Gribbi[illegible], ed., *Climate Change* (C[illegible]ibridge, England: Cambridge University Press, 1977; R. Rotty, "Global Energy Demand an[illegible] Related Climate Change;" IEA(M)–75–3 (Oak Ridge: Institute for Energy Analysis, November 1975); W. Häfele, RR–76–1, IIASA (Laxenburg, Austria), pp. 15, 144–97. The CO_2 problem, as Häfele shows, is remarkably insensitive to technical (e.g., nuclear) assumptions if a high energy future is assumed.

[6] Figure 2–1 shows only *nonagricultural energy*. Yet the sunlight participating in photosynthesis in our harvested *crops* is comparable to our total use of nonagricultural energy, while the sunlight falling on *all* U.S. croplands and grazing lands is about twenty-five times the nonagricultural energy. By any measure, sunlight is the largest single energy input to the U.S. economy today.

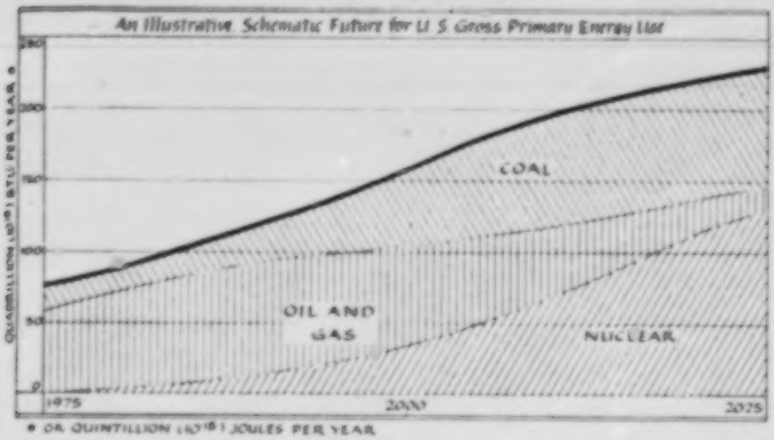

FIGURE 2-1

Among the most intractable barriers to implementing Figures 2-1 is its capital cost. In the 1960s, the total investment to increase a consumer's delivered energy supplies by the equivalent of one barrel of oil per day (about 67 kilowatts of heat) was a few thousand of today's dollars—of which, in an oil system, the wellhead investment in the Persian Gulf was and still is only a few hundred dollars. (The rest is transport, refining, marketing, and distribution.) The capital intensity of much new coal supply is still in this range. But such cheaply won resources can no longer stretch our domestic production of fluid fuels or electricity; and Figure 2-1 relies mainly on these, not on coal burned directly, so it must bear the full burden of increased capital intensity.

That burden is formidable. For the North Sea oilfields coming into production soon, the investment in the whole system is roughly $10,000 to deliver an extra barrel per day (constant 1976 dollars throughout); for U.S. frontier (Arctic and offshore) oil and gas in the 1980s it will be generally in the range from $10,000 to $25,000; for synthetic gaseous and liquid fuels made from coal, from $20,000 to $50,000 or more per daily barrel.

The scale of these capital costs is generally recognized in the industries concerned. What is less widely appreciated—partly because capital costs of electrical capacity are normally calculated per installed (not delivered) kilowatt and partly because whole system costs are rarely computed—is that capital cost is many times greater for new systems that make electricity than for those that burn fuel directly. For coal-electric capacity ordered today, a reasonable estimate would be about $170,000 for the delivered equivalent of one barrel of oil per day; for nuclear-electric capacity ordered today, about $200,000–$300,000. Thus, the capital cost per delivered kilowatt of electric energy emerges as roughly one hundred times that of the traditional direct fuel technologies on which our society has been built.[7]

The capital intensity of coal conversion and, even more, of large electrical stations and distribution networks is so great that many analysts, such as the strategic planners of the Shell Group in London, have concluded that no major country outside the Persian Gulf can afford these centralized high technologies on a truly large scale, large enough to run a country. They are looking, in Monte Canfield's phrase, like future technologies whose time has passed.

Relying heavily on such technologies, the 1976–1985 energy program proposed in the January 1975 State of the Union Message turns out to cost over $1 trillion (in 1976 dollars) in initial investment, of which about 70 to 80 percent would be for new rather than replacement plants.[8] The latter figure corresponds to about three-fourths of cumulative net private domestic investment (NPDI) over the decade (assuming that NPDI remains 7 percent of gross national product and that GNP achieves real growth of 3.5 percent per year despite the adverse effects of the energy program on other investments). In contrast, the energy sector has recently required only one-fourth of NPDI. Diverting to the energy sector not only this hefty share of discretionary investment but also about two-thirds of all the rest would deprive other sectors that have their own cost escalation problems and their own vocal constituencies. A powerful political response could be expected. And this capital burden is not temporary; further up the curves of Figure 2–1 it tends to increase, and much of what might have been thought to be increased national wealth must be plowed back into the care and feeding of the energy system. Such long lead time, long payback time investments might also be highly inflationary.

Of the $1 trillion plus just cited, three-fourths would be for electrification. About 18 percent of the total investment could be saved just by reducing the assumed average 1976–1985 electrical growth rate from 6.5 to 5.5 percent per year.[9] Not surprisingly, the combination of disproportionate and rapidly increasing capital intensity, long lead times, and economic responses is already proving awkward to the electric utility industry, despite the protection of a 20 percent taxpayer subsidy on new power stations.[10] "Probably no industry," observes Bankers Trust Company, "has come closer to the edge of financial disaster." In many countries today an effective feedback loop is observable: large capital programs → poor cash flow → higher electricity prices → reduced demand growth → worse cash flow → increased bond flotation → increased debt-to-equity ratio, worse coverage, and less attractive bonds → poor bond sales → worse cash flow → higher electricity prices → reduced (even negative) demand growth and political pressure on utility regulators → overcapacity, credit pressure, and higher cost of money → worse cash flow, etc. This "spiral of impossibility," as Mason Willrich has called it, is exacerbated by most utilities' failure to base historic prices on the long-run cost of new supply: thus some must now tell their customers that the current dollar cost of a kilowatt-hour will treble by 1985, and that two-thirds of that increase will be capital charges for new plants. Moreover, experience abroad suggests that even a national treasury cannot long afford electrification: a New York State-like position is quickly reached, or too little money is left over to finance the energy uses, or both.

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[7] The capital costs for frontier fluids and for electrical systems can be readily calculated from the data base of the Bechtel model (see *supra* note 2).

[8] The Bechtel model, using 1974 dollars and assuming ordering in early 1974, estimates direct construction costs totaling $559 billion, including work that is in progress but not yet commissioned in 1985. Interest, design, and administration—but not land, nor escalation beyond the GNP inflation rate—bring the total to $743 billion. Including the cost of land, and correcting to a 1976 ordering date and 1976 dollars, is estimated by M. Carasso to yield over $1 trillion.

[9] M. Carasso et al., *supra* note 2.

[10] E. Kahn et al., "Investment Planning in the Energy Sector," LBL–4479 (Berkeley, California: Lawrence Berkeley Laboratory, 1 March 1976). See also T. D. Mount & L. D. Chapman, in *Proceedings of the Workshop on Energy Demand* (22–23 May 1976), CP–76–1 (Laxenburg, Austria: IIASA, 1976), p. 164.

2.4. IMPROVING ENERGY EFFICIENCY

Summarizing a similar situation in Britain, Walter Patterson concludes: "Official statements identify an anticipated 'energy gap' which can be filled only with nuclear electricity; the data do not support any such conclusion, either as regards the 'gap' or as regards the capability of filling it with nulear electricity." We have sketched one form of the latter argument; let us now consider the former.

Despite the steeply rising capital intensity of new energy supply, forecasts of energy demand made as recently as 1972 by such bodies as the Federal Power Commission and the Department of the Interior wholly ignored both price elasticity of demand and energy conservation. The Chase Manhattan Bank in 1973 (and again in 1976) saw virtually no scope for conservation save by minor curtailments: the efficiency with which energy produced economic outputs was assumed to be optimal already. In 1977, some analysts still predict economic calamity if the United States does not continue to consume twice the combined energy total for Africa, the rest of North and South America, and Asia except Japan. But what have more careful studies taught us about the scope for doing better with the energy we have? Since we can't keep the bathtub filled because the hot water keeps running out, do we really (as Malcolm MacEwen asks) need a bigger water heater, or could we do better with a cheap, low technology plug?

There are two ways, divided by a somewhat fuzzy line, to do more with less energy. First, we can plug leaks and use thriftier technologies to produce exactly the same output of goods and services—and bads and nuisances—as before, substituting other resources (capital, design, management, care, etc.) for some of the energy we formerly used. When measures of this type use today's technologies, are advantageous today by conventional economic criteria, and have no significant effect on lifestyles, they are called "technical fixes."

In addition, or instead, we can make and use a smaller quantity or a different mix of the outputs themselves, thus to some degree changing (or reflecting ulterior changes in) our lifestyles. We might do this because of changes in personal values, rationing by price or otherwise, mandatory curtailments, or gentler inducements. Such "social changes" include carpooling, smaller cars, mass transit, bicycles, walking, opening windows, dressing to suit the weather, and extensively recycling materials. Technical fixes, on the other hand, include thermal insulation, heat pumps (devices like air conditioners that move heat around—often in either direction—rather than making it from scratch), more efficient furnaces and car engines, less overlighting and overventilation in commercial buildings, and recuperators for waste heat in industrial processes. Hundreds of technical and semitechnical analyses of both kinds of conservation have been done; in the last two years especially, much analytic progress has been made.

Theoretical analysis suggests that, in the long term, technical fixes *alone* in the United States could probably improve energy efficiency by a factor of at least three or four.[11] A recent review of specific practical measures cogently argues that with only those technical fixes that could be implemented by about the turn of the century, Americans could nearly double the efficiency with which they use energy.[12] If that is correct, economic activity could increase steadily with approximately constant primary energy use for the next few decades, thus stretching present energy supplies rather than having to add massively to them. One careful comparison shows that *after* correcting for differences of climate, geography, hydroelectric capacity, etc., Americans would still use about a third less energy than they do now if they were as efficient as the Swedes (who see much room for improvement in their own efficiency).[13] U.S. per capital energy intensity, too, is about twice that of West Germany in space heating, four times in transport.[14] Much of the difference is attributable to technical fixes.

Some technical fixes are already under way in the United States. Extensive new federal and state legislation is starting to be implemented. Many factories have cut tens of percent off their fuel cost per unit output, often with practically no capital investment. New 1976 cars averaged 27 percent better mileage than 1974 models. And there is overwhelming evidence that technical fixes are generally much cheaper than increasing energy supply, as well as quicker, safer, and of more lasting benefit. They are also better for secure, broadly based employment using existing skills. Most energy conservation measures and the shifts of consumption that they occasion are relatively labor-intensive. Even making more energy-efficient home appliances is about twice as good for jobs as is building power stations: the latter is practically the least labor-intensive major investment in the whole economy.

The capital savings of conservation are particularly impressive. In the terms used above, the investments needed to *save* the equivalent of an extra barrel of oil per day are often zero to $3500, generally under $8000, and at most about $25,000—far less than the amounts needed to increase most kinds of energy supply. Indeed, to use energy efficiently in new buildings, especially commercial ones, the additional capital cost is often *negative*: savings on heating and cooling equipment more than pay for the other modifications.

To take one major area of potential saving, technical fixes in new buildings—almost anywhere in the world—can save 50 percent or more in office buildings and 80 percent or more in some new U.S.

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[11] American Institute of Physics Conference Proceedings No. 25, *Efficient Use of Energy* (New York: AIP, 1975), summarized in *Physics Today*, August 1975.

[12] M. Ross and R. H. Williams, *Bull. Atom. Scient.* 32:9, 30–38 (November 1976) and *Technology Review*, in press (1977); see also L. Schipper, *Ann. Rev. Energy* 1:455–518 (1976); and R. H. Socolow, "The Coming Age of Conservation," *Ann. Rev. Energy* 2: in press (1977).

[13] L. Schipper and A.J. Lichtenberg, *Science* 194:1001–13 (1976).

[14] R. L. Goen and R. K. White, "Comparison of Energy Consumption Between West Germany and the United States" (Menlo Park, California: Stanford Research Institute, June 1975).

houses.[15] A recent American Institute of Architects study concludes that, by 1990, improved design of new buildings and modification of old ones could save a third of our current *total* U.S. energy use—and save money too. The payback time would be only half that of the alternative investment in increased energy supply, so the same capital could be used twice over.

A second major area lies in "cogeneration," or the generating of electricity as a by-product of the process steam normally produced in many industries. A Dow study chaired by Paul McCracken reports that by 1985 U.S. industry could meet approximately half its own electricity needs (compared to about a seventh today) by this means. Such cogeneration would save $20–50 billion in investment, save fuel equivalent to two to three million barrels of oil per day, obviate the need for more than fifty large reactors, and (with flattened utility rates) yield at least 20 percent pretax return on marginal investment while reducing the price of electricity to consumers.[16] Another measure of the potential is that cogenertion, whose contribution to U.S. electricity supply has fallen from about 15 percent in 1950 to about 4 percent today, still supplies about 12 percent in West Germany. Cogeneration and more efficient use of electricity could together reduce U.S. use of electricity by a third and central station generation by 60 percent.[17] Like district heating (distribution of waste heat as hot water via insulated pipes to heat buildings), U.S. cogeneration is held back only by institutional barriers. Yet these are smaller than those that were overcome when the present utility industry was established.

So great is the scope for technical fixes now that the U.S. could spend several hundred billion dollars on them initially plus several hundred million dollars per day—and still save money compared with increasing the suppy! And one would still have the fuel (without the environmental and geopolitical problems of getting and using it). The barriers to far more efficient use of energy are not technical, nor in any fundamental sense economic. So why do we stand here, confronted, as Pogo said, by insurmountable opportunities?

The answer—apart from poor information and ideological antipathy and rigidity—is a wide array of institutional barriers, including more than 3000 conflicting and often obsolete building codes, an innovation-resistant building industry, lack of mechanisms to ease the transition from kinds of work that we no longer need to kinds we do need, opposition by strong unions to schemes that would transfer jobs from their members to larger numbers of less "skilled" workers, promotional utility rate structures, fee structures giving building engineers a fixed percentage of prices of heating and cooling equipment they install, inappropriate tax and mortgage policies, conflicting signals to consumers, misallocation of conservation's costs and benefits (builders versus buyers, landloards versus tenants, etc.), imperfect access to capital markets, fragmentation of government responsibility, etc.

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[15] A. D. Little, Inc., "An Impact Assessment of ASHRAE Standard 90–75," report to FEA, C-78309, December 1975; J. E. Snell et al. (National Bureau of Standards), "Energy Conservation in Office Buildings: Some United States Examples," International CIB Symposium on Energy Conservation in the Built Environment (Building Research Establishment, Garston, Watford, England, April 1976 (Hornby, Lancs.: Construction Press Ltd., 1976); Owens-Corning Fiberglas (Toledo, Ohio), "The Arkansas Story," 1975; E. Hirst, *Science* *194*:1247 (1976); recent publications of the American Institute of Architects (Washington, D.C.); Dubin-Mindell-Bloome Associates, *A Study of Existing Energy Usage on Long Island and the Impact of Energy Conservation, Solar Energy, Total Energy and Wind Systems on Future Requirements* (New York, 31 October 1975).

[16] P. W. McCracken et al. *Industrial Energy Center Study*, Dow Chemical Co. et al. report to NSF, PB-243 824, NTIS, June 1975. Two important studies published more recently have examined a wider range of sizes and types of cogeneration systems and have concluded that the Dow report substantially underestimates the potential: S. E. Nydick et al., "A Study of Inplant Electric Power Generation in the Chemical, Petroleum Refining, and Paper and Pulp Industries," Thermo Electron Corporation report to FEA, PB-255-658 and -659, NTIS, May 1976; and R. H. Williams, "The Potential for Electricity Generation as a By-product of Industrial Steam Production in New Jersey," report to N.J. Cabinet Energy Committee (Princeton, New Jersey: Center for Environmental Studies, Princeton University, 21 June 1976).

[17] Ross and Williams, *supra* note 12. A further 5 quad saving in U.S. primary energy through currently economic combined heat and power stations and district heating grids—which could reach at least half the U.S. population—is calculated by J. Karkheck et al., *Science* *195*:948–55 (1977).

Though economic answers are not always right answers, properly using the markets we have (see Chapter 1.5) may be the greatest single step we could take toward a sustainable, humane energy future. The sound economic principles we need to apply include flat (even inverted) utility rate structures rather than discounts for large users, pricing energy according to what extra supplies will cost in the long run ("long-run marginal cost pricing"), removing subsidies, assessing the total costs of energy-using purchases over their whole operating lifetimes ("life cycle costing"), counting the costs of complete energy systems including all support and distribution systems, properly assessing and charging environmental costs, valuing assets by what it would cost to replace them, discounting appropriately, and encouraging competition through antitrust enforcement (including at least horizontal divestiture of giant energy corporations).

Such practicing of the market principles we preach could go very far to help us use energy efficiently and get it from sustainable sources. But just as clearly, there are things the market cannot do, like reforming building codes or utility practices. And whatever our means, there is room for differences of opinion about how far we can achieve the great theoretical potential for technical fixes. How far might we instead choose, or be driven to, some of the "social changes" mentioned earlier?

There is no definitive answer to this question—though it is arguable that if we are not clever enough to overcome the institutional barriers to implementing technical fixes, we shall certainly not be clever enough to overcome the more familiar but more formidable barriers to increasing energy supplies. My own view of the evidence is, first, that North Americans are adaptable enough to use technical fixes *alone* to double, in the next few decades, the amount of social benefit wrung from each unit of end-use energy; and second, that value changes that could either replace or supplement those technical changes are also occurring rapidly. If either of these views is right, or if both are partly right, North Americans should be able to double end-use efficiency by the turn of the century or shortly thereafter, with minor or no changes in lifestyles or values save increasing comfort for modestly increasing numbers, then over the period 2010–2040 to shrink per capita primary energy use to perhaps a third or a quarter of today's.[18] (The former would reach the per capita level of the wasteful, but hardly troglodytic, French; the latter, the level of the New Zealanders or the 1970 Swiss). Even in the case of fourfold shrinkage, the resulting society could be instantly recognizable to a visitor from the 160s and need in no sense be a pastoralist's utopia—though that option would remain open to those who may desire it.

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[18] A calculation for Canada supports this view: A.B. Lovins, *Conserver Society Notes* (Ottawa: Science Council of Canada, May/June 1976), pp. 3–16. Technical fixes already approved in principle by the Canadian Cabinet should hold approximately constant until 1990 the energy required for the transport, commercial, and house-heating sectors; sustaining similar measures to 2025 is estimated to shrink per capita primary energy to about half today's level. Plausible social changes are estimated to yield a further halving. The Canadian and U.S. energy systems have rather similar structures. The potential for increasing end-use efficiency is considerably less in Europe than in North America: a doubling might be expected in Europe over the next fifty years or so, rather than the North American quadrupling.

The long-term mix of technical fixes with structural and value changes in work, leisure, agriculture, and industry will require much trial and error. It will take many years to make up our diverse minds about. It will not be easy—merely easier than not doing it. Meanwhile, it is easy only to see what not to do.

If one assumes that by resolute technical fixes and modest social innovation North Americans can double their end-use efficiency by shortly after 2000, then they could be twice as affluent as now with today's level of energy use, or as affluent as now while using only half the end-use energy they use today. Or they might be somewhere in between—significantly more affiuent (and equitable) than today but with less end-use energy.

Many analysts now regard modest, zero, or negative growth in the rate of energy use in industrial countries as a realistic long-term goal. Present annual U.S. primary energy demand, for example, is about seventy-five quadrillion BTU ("quads"), and most official projections for 2000 envisage growth to 130–170 quads. However, recent work at the Institue for Energy Analysis, Oak Ridge, under the direction of Dr. Alvin Weinberg, suggests that standard projections of energy demand are far too high because they do not take into account changes in demographic and economic trends. In June 1976 the institute considered that with a conservation program far more modest than that contemplated in this article, the likely range of U.S. primary energy demand in the year 2000 would be about 101–126 quads, with the lower end of the range more probable and end-use energy being about 60–65 quads, much less than is considered here. In early 1977, Professors R. H. Williams and F. von Hippel of Princeton University likewise showed in their testimony to the Nuclear Regulatory Commission's GESMO hearings that 112 quads in 2000 could be considered a "business-as-usual" projection assuming only the conservation measures already enacted, with further modest conservation yielding only ninety-five quads. And, at the further end of the spectrum, projections of U.S. primary energy for 2010 being seriously studied by the Committee on Nuclear and Alternative Energy Systems, a major U.S. National Research Council study due to report in mid-1977, ranged as low as about seventy quads (fifty-four quads of fuels plus sixteen of solar energy), with an even lower figure (forty to fifty quads total primary energy) being examined.

As the basis for a coherent alternative to the path shown in Figure 2–1, Figure 2–2 sketches a primary energy demand of about ninety-five quads for 2000—a value that the above data suggest is by no means the lowest that could be realistically considered. Total energy demand would gradaully decline thereafter as inefficient buildings, machines, cars, and energy systems are slowly modified or replaced. Let us now explore the other ingredients of such a path—starting with the "soft" supply technologies which, spurned in Figure 2–1 as insignificant, now assume great importance.

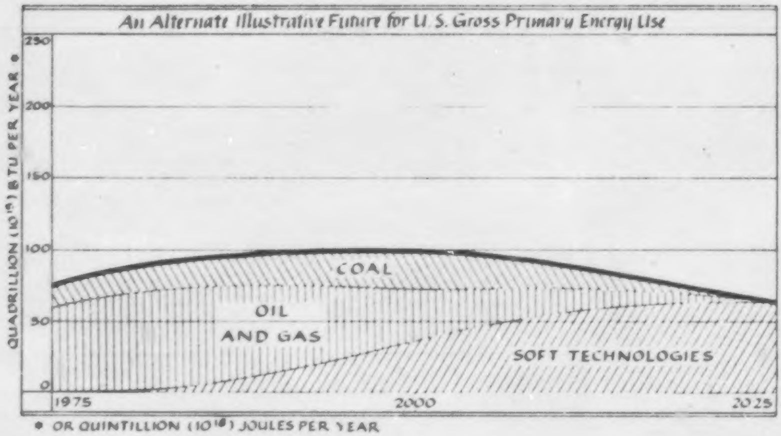

FIGURE 2-2

2.5. SOFT ENERGY TECHNOLOGIES

There exists today a body of energy technologies that have certain specific features in common and that offer great technical, economic, and political attractions, yet for which there is no generic term. For lack of a more satisfactory term, I shall call them "soft" technologies: a textural description, intended to mean not vague, mushy, speculative, or ephemeral, but rather flexible, resilient, sustainable, and benign. Energy paths dependent on soft technologies illustrated in Figure 2-2, will be called "soft" energy paths, as the "hard" technologies sketched in Chapter 2.2 constitute a "hard" path (in both senses). The distinction between hard and soft energy paths rests not on how much energy is used, but on the technical and sociopolitical *structure* of the energy system, thus focusing our attention on consequent and crucial political differences.

In Figure 2–2, then, the social structure is significantly shaped by the rapid deployment of soft technologies. These are defined by five characteristics:

1. They rely on renewable energy flows that are always there whether we use them or not, such as sun and wind and vegetation: on energy income, not on depletable energy capital.
2. They are diverse, so that as a national treasury runs on many small tax contributions, so national energy supply is an aggregate of very many individually modest contributions, each designed for maximum effectiveness in particular circumstances.
3. They are flexible and relatively low technology—which does not mean unsophisticated, but rather, easy to understand and use without esoteric skills, accessible rather than arcane (see Chapter Nine).
4. They are matched in *scale* and in geographic distribution to end use needs, taking advantage of the free distribution of most natural energy flows.

5. They are matched in *energy quality* to end-use needs: a key feature that deserves immediate explanation.

People do not want electricity or oil, nor such economic abstractions as "residential services," but rather comfortable rooms, light, vehicular motion, food, tables, and other real things. Such end-use needs can be classified by the physical nature of the task to be done (see Chapter Four). In the United States today, about 58 percent of all energy at the point of end use is required as heat, split roughly 23–25 between temperatures above and below the boiling point of water. (In Western Europe the low temperature heat alone is often a half of all end-use energy.) Another 38 percent of all U.S. end use energy provides mechanical motion: 31 percent in vehicles, 3 percent in pipelines, 4 percent in industrial electric motors. The rest, a mere 4 percent of delivered energy, represents *all lighting*, electronics, telecommunications, electrometallurgy, electrochemistry, arc welding, electric motors in home appliances and in railways, and similar end uses that now *require* electricity.

Some 8 percent of all U.S. energy end use, then, and similarly little abroad (see Chapter 4), requires electricity for purposes other than low temperature heating and cooling. Yet, since we actually use electricity for many such low grade purposes, it now meets 13 percent of U.S. end-use needs—and its generation consumes 29 percent of U.S. fossil fuels. A hard energy path would increase this 13 percent figure to 20–40 percent (depending on assumptions) by the year 2000, and far more thereafter. But this is wasteful because the laws of physics require, broadly speaking, that a power station change three units of fuel into two units of almost useless waste heat plus one unit of electricity. The electricity can do more difficult kinds of work than can the original fuel, but unless this extra quality and versatility are used to advantage, the costly process of upgrading the fuel—and losing two-thirds of it—is all for naught.

Plainly we are using premium fuels and electricity for many tasks for which their high energy quality is superfluous, wasteful, and expensive, and a hard path would make this inelegant practice even more common. Where we want only to create temperature differences of tens of degrees, we should meet the need with sources whose potential is tens or hundreds of degrees, not with a flame temperature of thousands or a nuclear reaction temperature equivalent to trillions—like cutting butter with a chainsaw.

For some applications, electricity is appropriate and indispensable: electronics, smelting, subways, most lighting, some kinds of mechanical work, and a few more. But these uses are already oversupplied, and for the other, dominant, uses remaining in our energy economy this special form of energy cannot give us our money's worth (in many parts of the United States today it already costs $50–120 per barrel equivalent). Indeed, in probably no industrial country today can additional supplies of electricity be used to thermodynamic advantage that would justify their high cost in money and fuels.

So limited are the U.S. end uses that really require electricity that by applying careful technical fixes to them we could reduce their 8 percent total to about 5 percent (mainly by reducing commercial overlighting), whereupon we could probably cover all those needs with present U.S. hydroelectric capacity plus the cogeneration capacity available in the mid to late 1980s.[19] Thus an affluent industrial economy could advantageously operate with no central power stations at all! In practice we would not necessarily want to go that far, at least not for a long time; but the possibility illustrates how far we are from supplying energy only in the quality needed for the task at hand.

Just as soft technologies' matching of energy quality to end-use needs virtually eliminates the costs and losses of secondary energy conversion, so the appropriate scale (see Chapter Five) of soft technologies can virtually eliminate the costs and losses of energy distribution. Matching scale to end uses can indeed achieve at least five important types of economies (see Chapter Five) not available to larger, more centralized systems. The first type is reduced and shared overheads. At least half your electricity bill is fixed distribution costs to pay the overheads of a sprawling energy system: transmission lines, transformers, cables, meters and people to read them, planners, headquarters, billing computers, interoffice memos, advertising agencies. For electrical and some fossil fuel systems, distribution accounts for more than half of total capital cost, and administration for a significant fraction of total operating cost. Local or domestic energy systems can reduce or even eliminate these infrastructure costs. The resulting savings can far outweigh the extra costs of the dispersed maintenance infrastructure that the small systems require, particularly where that infrastructure already exists or can be shared (e.g., plumbers fixing solar heaters as well as sinks).

Small scale brings further savings by virtually eliminating distribution losses, which are cumulative and pervasive in centralized energy systems (particularly those using high quality energy). Small systems also avoid direct diseconomies of scale, such as the frequent unreliability of large units and the related need to provide instant "spinning reserve" capacity on electrical grids to replace large stations that suddenly fail. Small systems with short lead times greatly reduce exposure to interest, escalation, and mistimed demand forecasts—major indirect diseconomies of large scale.

The fifth type of economy available to small system arise from mass production. Consider, as Henrik Harboe suggests, the 100-odd million cars in the U.S. In round numbers, each car probably has an average cost of less than $4,000 and a shaft power over 100 kilowatts (134 horsepower). Presumably a good engineer could build a generator and upgrade an automobile engine to a reliable, 35 percent efficient diesel at no greater total cost, yielding a mass-produced diesel generator unit costing less than $40 per kW. In contrast, the motive capacity in U.S. central power stations—currently totaling about one-fortieth as much as in U.S. cars—costs perhaps ten times more per kW, partly because it is not mass produced. This is not to argue for the widespread use of diesel generators; rather, to suggest that if we could build power stations the way we build cars, they would cost at least ten times less than they do, but we can't because they're too big. In view of this scope for mass-producing small systems, it is not surprising that at least one European car maker hopes to go into the wind machine and heat pump business. Such a market can be entered incrementally, without the billions of dollars' investment required for, say, liquefying natural gas or gasifying coal. It may require a production philosophy oriented toward technical simplicity, low replacement cost, slow obsolescence, high reliability, high volume, and low markup; but these are familiar concepts in mass production. Industrial resistance would presumably melt when—as with pollution abatement equipment—the scope for profit was perceived.

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[19] The scale of potential conservation in this area is given in Ross and Williams, *supra* note 12; the scale of potential cogeneration capacity is from McCracken et al., and from Nydick et al., *supra* note 16.

This is not to say that all energy systems need be at domestic scale. The object is to crack nuts with nutcrackers and drive pilings with triphammers, not the reverse: to use the most appropriately scaled tool for the job and so minimize costs, including social costs. In some cases this will require big systems, chiefly the existing hydroelectric dams. In most cases the scale needed will be smaller. For example, the medium scale of urban neighborhoods and rural villages offers fine prospects for solar collectors—especially for adding collectors to existing buildings of which some (perhaps with large flat roofs) can take excess collector area while others cannot take any. They could be joined via communal heat storage systems, saving on labor cost and on heat losses. The costly craftwork of remodeling existing systems—"backfitting" or "retrofitting" idiosyncratic houses with individual collectors—could thereby be greatly reduced. Despite these advantages, medium-scale solar technologies are currently receiving little attention apart from a condominium village project in Vermont sponsored by the Department of Housing and Urban Development and the one hundred dwelling unit Méjannes-le-Clap project in France.

The schemes that dominate ERDA's solar research budget—such as making electricity from huge collectors in the desert, or from temperature differences in the oceans, or from Brooklyn Bridge-like satellites in outer space—do not satisfy our criteria, for they are ingenious high technology ways to supply energy in a form and at a scale inappropriate to most end-use needs. Not all solar technologies are soft. Nor, for the same reason, is nuclear fusion a soft technology.[20] But many genuine soft technologies are now available and are now economic. What are some of them?

Solar heating and, imminently, cooling head the list. They are incrementally cheaper than electric heating, and far more inflation-proof, practically anywhere in the world.[21] In the United States (with fairly high average sunlight levels), they are cheaper than present electric heating virtually anywhere, cheaper than oil heat in many parts, and cheaper than gas and coal in some. Even in the least favorable parts of the continental United States, far more sunlight falls on a typical building than is required to heat and cool it without supplement; whether this is considered economic depends on how the accounts are done.[22] The difference in solar input between the most and least favorable parts of the lower forty-nine states is generally less than twofold, and in cold regions, the long heating season can improve solar economics.

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[20] Assuming (which is still not certain) that controlled nuclear fusion works, it will almost certainly be more difficult, complex, and costly—though safer and perhaps more permanently fueled—than fast breeder reactors. See W. D. Metz, *Science* 192: 1320–23 (1976); *193*:38–40, 76 (1976); and *193*:307–309 (1976). But for three reasons we ought not to pursue fusion. First, it generally produces copious fast neutrons that can and probably would be used to make bomb materials. Second, if it turns out to be rather "dirty," as most fusion experts expect, we shall probably use it anyway, whereas if it is clean, we shall so overuse it that the resulting heat release will alter global climate: we should prefer energy sources that give us enough for our needs while denying us the excesses of concentrated energy with which we might do mischief to the earth or to each other. Third, fusion is a clever way to do something we don't really want to do, namely to find *yet another* complex, costly, large-scale, centralized, high technology way to make electricity—all of which goes in the wrong direction.

[21] Partial or total solar heating is attractive and is being demonstrated even in cloudy countries approaching the latitude of Anchorage, such as Denmark and the Netherlands (International CIB Symposium, *supra* note 15) and Britain (*Solar Energy: United Kingdom Assessment*, International Solar Energy Society, London, May 1976). See also Chapter Seven, note 38.

Ingenious ways of backfitting existing urban and rural buildings (even large commercial ones) or their neighborhoods with efficient and exceedingly reliable solar collectors are being rapidly developed in both the private and public sectors. In some recent projects, the lead time from ordering to operation has been only a few months. Good solar hardware, often modular, is going into pilot or full scale production over the next few years, and will increasingly be integrated into buildings as a multipurpose structural element, thereby sharing costs. Such firms as Philips, Honeywell, Revere, Pittsburgh Plate Glass, and Owens-Illinois, plus many dozens of smaller firms, are applying their talents, with rapid and accelerating effect, to reducing unit costs and improving performance. Some novel types of very simple collectors with far lower costs also show promise in current experiments. Indeed, solar hardware per se is necessary only for backfitting existing buildings. If we build new buildings properly in the first place, they can use "passive" solar collectors—large south windows or glass-covered black south walls—rather than special collectors. If we did this to all new houses in the next twelve years, we would save about as much energy as we expect to recover from the Alaskan North Slope.[23]

Second, exciting developments in the conversion of agricultural, forestry, and urban wastes to methanol and other liquid and gaseous fuels now offer practical, economically interesting technologies sufficient to run an efficient U.S. transport sector.[24] Some bacterial and enzymatic routes under study look even more promising, but presently proved processes already offer sizable contributions without the inevitable climatic constraints of fossil fuel combustion. Organic conversion technologies must be sensitively integrated with agriculture and forestry so as not to deplete the soil; most current methods seem suitable in this respect, through they may change the farmer's priorities by making his whole yield of biomass (vegetable matter) salable.

The required scale of organic conversion can be estimated. Each year the U.S. beer and wine industry, for example, microbiologically produces 5 percent as many gallons (not all alchohol, of course) as the U.S. oil industry produces gasoline. Gasoline has 1.5 to 2 times the fuel value of alcohol per gallon. Thus a conversion industry roughly ten to fourteen times the physical scale (in gallons of fluid output per year) of U.S. cellars and breweries, albeit using different processes, would produce roughly one-third of the present gasoline requirements of the United States. If one assumes a transport sector with three times today's average efficiency—a reasonable estimate for early in the next century—then the whole of the transport needs could be met by organic conversion. The scale of effort required does not seem unreasonable, since it would replace in function half the present refinery capacity.

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[22] Solar heating cost is traditionally computed microeconomically for a consumer whose alternative fuels are not priced at long-run marginal cost (see, e.g., G. Bennington et al.'s MITRE study M76/79, "An Economic Analysis of Solar Water and Space Heating" [November 1976], announced by the ERDA Solar Division on 29 December 1976 [release 76-376], which also assumes unrealistically high solar costs and 100% backup capacity). Another method would be to compare the total cost (capital and life cycle) of the solar system with the total cost of the other complete systems that would otherwise have to be used in the long run to heat the same space. On that basis, 100 percent solar heating, even with twice the capital cost of two-thirds or three-fourths solar heating, is almost always advantageous. See Chapter Eight, and H. A. Bethe and A. B. Lovins, exchange of letters, *Foreign Affairs*, April 1977.

[23] R. W. Bliss, *Bull. Atom Scient.* 32 : 3, 32–40 (March 1976).

[24] A.D. Poole and R.H. Williams, *Bull. Atom. Scient.* 32 :5, 48–58 (May 1976).

Additional soft technologies include wind hydraulic systems (especially those with a vertical axis), which already seem likely in many design studies to compete with nuclear power in much of North America and Western Europe. But wind is not restricted to making electricity: it can heat, pump, heat-pump, or compress air. Solar process heat, too, is coming along rapidly as we learn to use the 5800° C potential of sunlight (much hotter than a boiler). Finally, high and low temperature solar collectors, organic converters, and wind machines can form symbiotic hybrid combinations more attractive than the separate components.

Energy storage is often said to be a major problem of energy income technologies. But this "problem" is largely an artifact of trying to recentralize, upgrade and redistribute inherently diffuse energy flows. Directly storing sunlight or wind—or, for that matter, electricity from any source—is indeed difficult on a large scale. But it is easy if done on a scale and in an energy quality matched to most end use needs. Daily, even seasonal, storage of low and medium temperature heat at the point of use is straightforward with water tanks, rock beds, or perhaps fusible salts. Neighborhood heat storage is even cheaper. In industry, wind-generated compressed air can easily (and, with due care, safely) be stored to operate machinery: the technology is simple, cheap, reliable, and highly developed. (Some European cities even used to supply compressed air as a standard utility.) Installing pipes to distribute hot water (or compressed air) tends to be considerably cheaper than installing equivalent electric distribution capacity. Hydroelectricity is stored behind dams, and organic conversion yields readily stored liquid and gaseous fuels. On the whole, therefore, energy storage is much less of a problem in a soft energy economy than in a hard one.

Recent research suggests that a largely or wholly solar economy can be constructed in the United States with straightforward soft technologies that are now demonstrated and now economic or nearly economic.[23] Such a conceptual exercise does not require "exotic" methods such as sea-thermal, hot-dry-rock geothermal, cheap (perhaps organic) photovoltaic, or solar-thermal electric systems. If developed, as some probably will be, these technologies could be convenient, but they are in no way essential for an industrial society operating solely on energy income.

Figure 2-2 shows a plausible and realistic growth pattern, based on several detailed assessments for soft technologies given aggressive support. The useful output from these technologies would overtake, starting in the 1990s, the output of nuclear electricity shown in even the most sanguine federal estimates. For illustration, Figure 2–2 shows soft technologies meeting virtually all energy needs in 2025, reflecting a judgment that a completely soft supply mix is practicable in the long run, with or without the 2000–2025 energy shrinkage shown. Though most technologists who have thought seriously about the matter will concede it conceptually, some may be uneasy about the details. Obviously the sketched curve is not definitive, for although the general direction of the soft path must be shaped soon, the details of the energy economy in 2025 would not be committed in this century. To a large extent, therefore, it is enough to ask yourself whether Figure 2–1 or 2–2 seems preferable in the 1975–2000 period.

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[23] For examples, see the Canadian computations in A.B. Lovins, *Conserver Society Notes* (*supra* note 18), Bent Sørensen's Danish estimates in *Science 189*:255–60 (1975), and, as a useful data base, the forthcoming estimates by the Union of Concerned Scientists (*supra* note 1).

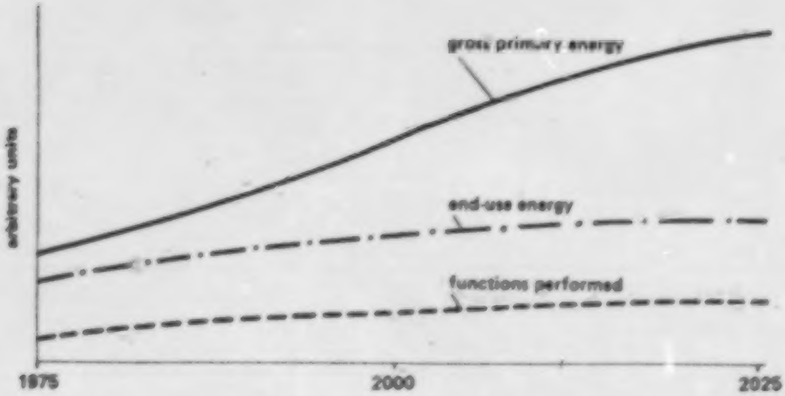
A simple comparison, shown schematically in Figure 2–3, may help. Roughly half, perhaps more, of the gross primary energy being produced in the hard path in 2025 is lost in conversions. A further appreciable fraction is lost in distribution. Delivered end-use energy is thus not vastly greater than in the soft path, where conversion and distribution losses have been all but eliminated. (What is lost can often be used locally for heating, and is renewable, not depletable.) But the soft path makes each unit of end-use energy perform several times as much social function as it would have done in the hard path; so in a conventional sense, social welfare in the soft path in 2025 is substantially greater than in the hard path at the same date.

2.6 TRANSITIONAL ENERGY TECHNOLOGIES

To fuse into a coherent strategy the benefits of energy efficiency and of soft technologies, we need one further ingredient: transitional technologies that use fossil fuels briefly and sparingly to build a bridge to the energy income economy of 2025, conserving those fuels—especially oil and gas—for petrochemicals (ammonia, plastics, etc.) and leaving as much as possible in the ground for emergency use only.

Some transitional technologies have already been mentioned under the heading of conservation—specifically, cogenerating electricity from existing industrial steam and using existing waste heat for district heating. Given such measures, increased end-use efficiency, and the rapid development of biomass alcohol as a portable liquid fuel, the principal short- and medium-termed problem becomes, not a shortage of electricity or of portable liquid fuels, but a shortage of clean sources of heat. It is above all the sophisticated use of coal, chiefly at modest scale, that needs development. Technical measures to permit the highly efficient use of this widely available fuel would be the most valuable transitional technologies.

Neglected for so many years, coal technologies is now experiencing a virtual revolution. We are developing supercritical gas extraction, flash hydrogenation, flash pyrolysis, panel-bed filters, and similar ways to use coal cleanly at essentially any scale and to cream off valuable liquids and gases as premium fuels before burning the rest. These methods largely avoid the costs, complexity, inflexibility, technical risks, long lead times, large scale, and tar formation of the traditional processes that now dominate our research.



(a) A HARD PATH

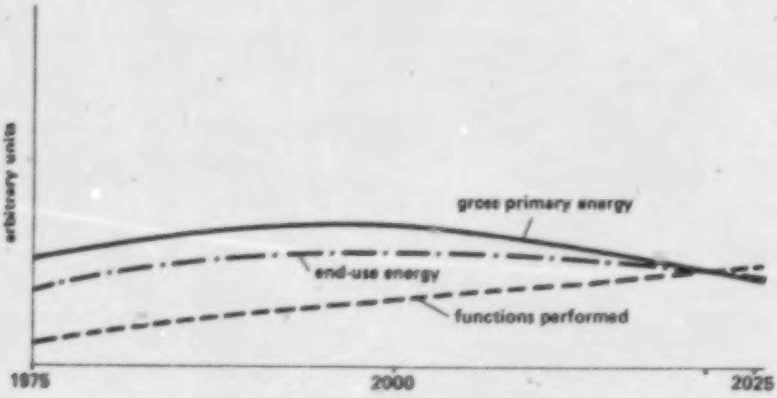


FIGURE 2-3. Schematic Sketch of Gross Primary Energy, End-Use Energy, and Quantity of Functions Performed by End-Use Energy in Hard and Soft Energy Paths.

Perhaps the most exciting current development is the so-called fluidized bed system for burning coal (or virtually any other combustible material). Fluidized beds are simple, versatile devices that add the fuel a little at a time to a much larger mass of small, inert, red-hot particles—sand or ceramic pellets—kept suspended as an agitated fluid by a stream of air continuously blown up through it from below. The efficiency of combustion, of other chemical reactions (such as sulfur removal), and of heat transfer is remarkably high because of the turbulent mixing and large surface area of the particles. Fluidized beds have long been used as chemical reactors and for burning trash, but are now ready to be commercially applied to raising steam and operating turbines. In one system currently available from Stal-Laval Turbin AB of Sweden, eight off the shelf, 70 megawatt gas turbines powered by fluidized bed combusters, together with district-heating networks and heat pumps, would heat as many houses as a $1 billion plus coal gasification plant, but would use only two fifths as much coal, cost a half to two-thirds as much to build, and burn more cleanly than a normal power station with the best modern scrubbers.[26]

Fluidized bed boilers and turbines can power giant industrial complexes, especially for cogeneration, and are relatively easy to backfit into old municipal power stations. Scaled down, a fluidized bed can be a tiny household device—clean, strikingly simple, and flexible—that can replace an ordinary furnace or grate and can recover combustion heat with an efficiency over 80 percent.[27] At medium scale such technologies offer versatile boiler backfits and improve heat recovery in flues. With only minor modifications they can burn practically any fuel. It is essential to commercialize all these systems now—not to waste a decade on highly instrumented but noncommercial pilot plants constrained to a narrow, even obsolete design philosophy.[28]

Transitional technologies can be built at appropriate scale so that soft technologies can be plugged into the system later. For example, if district heating uses hot water tanks on a neighborhood scale, those tanks can in the long run be heated by neighborhood solar collectors, wind-driven heat pumps, a factory, a pyrolyzer, a geothermal well, or whatever else becomes locally available—offering flexibility that is not possible at today's excessive scale.

Both transitional and soft technologies are worthwhile industrial investments that can recycle moribund capacity and underused skills, stimulate exports, and give engaging problems to innovative technologists. Though neither glamorous nor militarily useful, these technologies are socially effective—especially in poor countries that need such scale, versatility and simplicity even more than rich countries do.

Properly used, coal, conservation, and soft technologies together can squeeze the "oil and gas" wedge in Figure 2-2 from both sides—so far that most of the frontier extraction and medium-term imports of oil and gas become unnecessary and conventional resources are greatly stretched. Coal can fill the real gaps in the fuel economy with only a temporary and modest (less than twofold at peak) expansion of mining, not requiring the enormous infrastructure and social impacts implied by the scale of coal use in Figure 2-1.

In sum, Figure 2-2 outlines a prompt redirection of effort at the margin that lets us use fossile fuels intelligently to buy the time we need to change over to living on our energy income. The innovations required, both technical and social, compete directly and immediately with the incremental actions that constitute a hard energy path: fluidized beds versus large coal gasification plants and coal-electric stations, efficient cars versus offshore oil, roof insulation versus Arctic gas, cogeneration versus nuclear power. These two directions of development are mutually exclusive: the pattern of commitments of resources and time required for the hard energy path and the pervasive infrastructure that it acceretes gradually make the soft path less and less attainable. That is, our two sets of choices compete not only in what they accomplish, but also in what they allow us to contemplate later. They are logistically competitive, institutionally incompatible, and culturally antithetical. Figure 2-1 obscures this constriction of options, for it peers myopically forward, one power station at a time, extrapolating trend into destiny by self-fulfilling prophecy with no end clearly in sight. Figure 2-2, in contrast, works backward from a strategic goal, asks what we must do when in order to get there, and thus reveals the potential for a radically different path that would be invisible to anyone working forward in time by incremental ad-hocracy.

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[26] The system and its conceptual framework are described in several papers by H. Harboe, Managing Director, Stal-Laval (G.B.) Ltd., 41-7 Strand, London WC 2: "District Heating and Power Generation," 14 November 1975; "Advances in Coal Combustion and Its Applications," 20 February 1976; "Pressurized Fluidized Bed Combustion with Special Reference to Open Gas Turbines" (with C.W. Maude), May 1976. See also K.D. Kiang et al., "Fluidized-Bed Combustion of Coals," GFERC/IC-75/2 (CONF-750586), ERDA, May 1975.

[27] Small devices were pioneered by the late Professor Douglas Elliott. His associated firm, Fluidfire Development, Ltd. (Netherton), Dudley, W. Midlands, England), has sold many dozens of units for industrial heat treatment or heat recuperation. Field tests of domestic packaged fluidized bed boilers are in progress in the Netherlands and planned in Montana.

[28] In late 1977, Enköping, Sweden, expects to commission a 25 megawatt fluidized bed boiler for its district heating system. New reviews at the Institute for Energy Analysis, the U.S. House of Representatives Committee on Science and Technology, and elsewhere confirm fluidized beds' promise of rapid benefits without massive research programs. The Tennessee Valley Authority has announced plans to build a 200 MW fluidized bed boiler with or without ERDA's help.

2.7. LOGISTICS AND ECONOMICS

Both the soft and the hard paths bring us, each in its own way and at broadly similar rates, to the era beyond oil and gas. But the rates of internal adaptation meanwhile are different. As we have seen, the soft path relies on smaller, far simpler supply systems entailing vastly shorter development and construction time, and on smaller, less sophisticated management systems. Even converting the urban clusters of a whole country to district heating should take only thirty to forty years. Furthermore, the soft path relies mainly on small, standard, easy to make components and on technical resources dispersed in many organizations of diverse sizes and habits; thus everyone can get into the act, unimpeded by centralized bureaucracies, and can compete for a market share through ingenuity and local adaptation. Besides having much lower and more stable operating costs than the hard path, the soft path appears to have a lower *initial* cost because of its technical simplicity, small unit size, very low overhead, scope for mass production, virtual elimination of distribution losses and of interfuel conversion losses, low exposure to escalation and interest, and prompt incremental construction (so that new capacity is built only when and where it is needed.)[29]

The actual costs of whole systems, however, are not the same as perceived costs: solar investments are borne by the householder, electric investments by a utility that can float low interest bonds and amortize over thirty years. During the transitional era, we should therefore consider ways to broaden householders' access to capital markets. For example, the utility could finance the solar investment (leaving its execution to the householder's discretion), then be repaid in installments corresponding to the householder's saving. The householder would thus minimize his or her own—and society's—long-term costs. The utility would have to raise several times less capital than it would without such a scheme—for otherwise it would have to build new electric or synthetic gas capacity at even higher cost—and would turn over its money at least twice as quickly, thus retaining an attractive rate of return on capital. The utility would also avoid social obsolescence and use its existing infrastructure. Such incentives have already led several U.S. gas utilities to use such a capital transfer scheme to finance roof insulation in more than 100,000 houses.

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[29] Estimates of the total capital cost of "soft" systems are necessarily less well developed than those for the "hard" systems, but can be calculated well enough, assuming today's technologies, to make a good case that they are cheaper than the hard systems with which they compete as long-term replacements for dwindling fossil fuels. The calculations are given in Chapter Seven, with a summary and comparison in Chapter Eight. The methodology of such cost comparisons is discussed in Chapters One and Three. The general cost advantage of soft over hard technologies is as valid in Northern Europe as in the U.S.

Next, the two paths differ even more in risks than in costs. The hard path entails serious environmental risks, many of which are poorly understood and some of which have probably not yet been thought of. Perhaps the most awkward risk is that late in this century, when it is too late to do much about it, we may well find climatic constraints on coal combustion about to become acute in a few more decades: for it now takes us only that long, not centuries or millennia, to approach such outer limits. The soft path, by minimizing all fossil fuel combustion, hedges our bets. Its environmental impacts are relatively small, tractable, and reversible.[30]

The hard path, further, relies on a very few high technologies whose success is by no means assured. The soft path distributes the technical risk among very many diverse low technologies, most of which are already known to work well. They do need sound engineering—a solar collector or heat pump can be worthless if badly designed—but the engineering is of an altogether different and more forgiving order than the hard path requires, and the cost of failure is much lower both in potential consequences and in number of people affected. The soft path also minimizes the economic risks to capital in case of error, accident, or sabotage; the hard path effectively maximizes those risks by relying on vulnerable high technology devices, each costing more than the endowment of Harvard University. Finally, the soft path appears generally more flexible—and thus robust. Its technical diversity, adaptability, and geographic dispersion make it resilient and offer a good prospect of stability under a wide range of conditions, foreseen or not. The hard path, however, is brittle; it must fail, with widespread and serious disruption, if any of its exacting technical and social conditions is not satisfied continuously and indefinitely.

2.8 GEOPOLITICS

The soft path has novel and important international implications. Just as improvements in end-use efficiency can be used at home (via innovative financing and neighborhood self-help schemes) to lessen first the disproportionate burden of energy waste on the poor, so can soft technologies and reduced pressure on oil markets especially benefit the poor abroad. Soft technologies are ideally suited for rural villagers and urban poor alike, directly helping the more than two billion people who have no electric outlet nor anything to plug into it but who need ways to heat, cook, light, and pump. Soft techniques do not carry with them inappropriate cultural patterns or values; they capitalize on poor countries' most abundant resources (including such protein-poor plants as cassava eminently suited to making fuel alcohols) helping to redress the severe energy imbalance between temperate and tropical regions; they can often be made locally from local materials and do not require a technical elite to maintain them; they resist technological dependence and commerical monopoly; they conform to modern concepts of agriculturally based ecodevelopment from the bottom up, particularly in the rural villages.

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[30] See Chapter One, note 16, and A.B. Lovins, "Some Limits to Energy Conversion," in D. Meadows, ed., *Alternatives to Growth* (Cambridge, Massachusetts: Ballinger, 1977). The environmental and social impacts of solar technologies have been assessed in a study for the ERDA Solar Division (Chapter One, note 15).

Even more crucial, unilateral adoption of a soft energy path by the United States can go a long way to control nuclear proliferation—perhaps to eliminate it entirely. Many nuclear advocates have missed this point: believing that there is no alternative to nuclear power, they say that if the United States does not export nuclear technology, others will, so the U.S. might as well get the business and try to use it as a lever to slow the inevitable spread of nuclear weapons to nations and subnational groups in other regions. Yet the genie is not wholly out of the bottle yet—thousands of reactors are planned for a few decades hence, tens of thousands thereafter—and the cork sits unnoticed in our hands.

Perhaps the most important opportunity available to us stems from the fact that for at least the next five or ten years, while nuclear dependence and commitments are still reversible, all countries will continue to rely on the United States for the technical, the economic, and especially the *political* support they need to justify their own nuclear programs. Technical and economic dependence is intricate and pervasive; political dependence is far more important, but has been almost ignored, so we do not yet realize the power of the American example in an essentially imitative world where public and private divisions over nuclear policy are already deep and grow deeper daily.

The fact is that in almost all countries the domestic political base to support nuclear power is not solid but shaky. However great their nuclear ambitions, other countries must still borrow that political support from the United States. Few are succeeding. Nuclear expansion is all but halted by grassroots opposition in Japan and the Netherlands; has been severely impeded in West Germany, France, Switzerland, Italy, and Austria; has been slowed and may soon be stopped in Sweden; has been rejected in Norway and (so far) Australia and New Zealand, as well as in several Canadian provinces; faces an uncertain prospect in Denmark and many American states; has been widely questioned in Britain, Canada and the U.S.S.R.[31]; and has been opposed in Spain, Brazil, India, Thailand, and elsewhere.

Consider the impact of three prompt, clear U.S. statements:

1. The United States will phase out its nuclear power program [32] and its support of others' nuclear power programs.
2. The United States will redirect those resources into the tasks of a soft energy path and will freely and unconditionally help any other interested countries to do the same, seeking to adapt the same broad principles to others' needs and to learn from shared experience.

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[31] Recent private reports indicate the Soviet scientific community is deeply split over the wisdom of nuclear expansion. See also *Nucleonics Week*, 13 May 1976, pp. 12–13.

[32] Current overcapacity, capacity under construction, and the potential for rapid conservation and cogeneration make this a relatively painless course, whether nuclear generation is merely frozen or phased out altogether. For an illustration (the case of California), see R. Doctor et al., *Sierra Club Bulletin*, May 1976, pp. 4ff. I believe the same is true abroad. See Introduction to *Non-Nuclear Futures* by A. B. Lovins and J. H. Price (Cambridge, Massachusetts: FOE/Ballinger, 1975).

3. The United States will start to treat nonproliferation, control of civilian fission technology, and strategic arms reduction as interrelated parts of the same problem with intertwined solutions.

I believe that such a universal, nondiscriminatory package of policies would be politically irresistible to North and South, East and West alike. It would offer perhaps our best chance of transcending the hypocrisy that has stalled arms control: by no longer artifically divorcing civilian from military nuclear technology, we would recognize officially the real driving forces behind proliferation; and we would no longer exhort others not to acquire bombs while claiming that we ourselves feel more secure with bombs than without them.

Nobody can be certain that such a package of policies, going far beyond a mere moratorium would work. The question has received far too little thought, and political judgments differ. My own, based on the past ten years' residence in the midst of the European nuclear debate, is that nuclear power could not flourish there if the United States did not want it to.[33] In giving up the export market that her own reactor designs have dominated, the U.S. would be demonstrating a desire for peace, not profit, thus allaying legitimate European commercial suspicions. Those who believes such a move would be seized upon gleefully by, say, French exporters are seriously misjudging French nuclear politics. Skeptics, too, have yet to present a more promising alternative—a credible set of technical and political measures for meticulously restricting to peaceful purposes extremely large amounts of bomb materials that, once generated, will persist for the foreseeable lifetime of our species.

I am confident that the United States can still turn off the technology that is originated and deployed. By rebottling that genie we could all move to energy and foreign policies that our grandchildren can live with. No more important step could be taken toward revitalizing the American dream and making its highest ideals a global reality.

2.9 SOCIOPOLITICS

Perhaps the most profound difference between the soft and hard paths—the difference that ultimately distinguishes them—is their domestic sociopolitical impact. Both paths, like any fifty-year energy path, entail significant social change. But the kinds of social change needed for a hard path are apt to be much less pleasant, less plausible, less compatible with social diversity and personal freedom of choice, and less consistent with traditional values than are the social changes that could make a soft path work.

It is often said that, on the contrary, a soft path must be repressive; and coercive paths to energy conservation and soft technologies can indeed be imagined. But coercion is not necessary and its use would signal a major failure of imagination, given the many policy instruments available to achieve a given technical end. Why use penal legislation to encourage roof insulation when tax incentives and education (leading to the sophisticated public understanding now being achieved in Canada and parts of Europe) will do? Policy tools need not harm lifestyles or liberties if chosen with reasonable sensitivity.

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[33] See *Nucleonics Week*, 6 May 1976, p. 7, and I. C. Bupp and J. C. Derian, "Nuclear Reactor Safety: The Twilight of Probability," *Harv. Bus. School Bull.*, March–April 1976. Bupp, after a detailed study of European nuclear politics, shares this assessment.

In contrast to the soft path's dependence on pluralistic consumer choice in deploying a myriad of small devices and refinements, the hard path depends on difficult, large-scale projects requiring a major social commitment under centralized management. We have noted in section 2.3 the extraordinary capital intensity of centralized, electrified high technologies. Their similarly heavy demands on other scarce resources—skills, labor, materials, special sites—likewise cannot be met by market allocation, but require compulsory diversion from whatever priorities are backed by the weakest constituencies. Quasi-warpowers legislation to this end has already been seriously proposed. The hard path, sometimes portrayed as the bastion of free enterprise and free markets, would instead be a world of subsidies, $100 billion bailouts, oligopolies, regulations, nationalization, eminent domain, corporate statism.

Such dirigiste autarchy is the first of many distortions of the political fabric. While soft technologies can match any settlement pattern, their diversity reflecting our own pluralism, centralized energy sources encourage industrial clustering and urbanization. While soft technologies give everyone the costs and benefits of the energy system he or she chooses, centralized systems inequitably allocate benefits to suburbanites and social costs to politically weaker rural agrarians. Siting big energy systems pits central authority against local autonomy in an increasingly divisive and wasteful form of centrifugal politics that is already proving one of the most potent constraints on expansion.

In an electrical world, your lifeline comes not from an understandable neighborhood technology run by people you know who are at your own social level, but rather from an alien, remote, and perhaps humiliatingly uncontrollable technology run by a faraway bureaucratized, technical elite who have probably never heard of you. Decisions about who shall have how much energy at what price also become centralized—a politically dangerous trend because it divides those who use energy from those who supply and regulate it. Those who do not like the decisions can simply be disconnected.

The scale and complexity of centralized grids not only make them politically inaccessible to the poor and weak, but also increase the likelihood and size of malfunctions, mistakes, and deliberate disruptions. A small fault or a few discontented people become able to turn off a country. Even a single rifleman can probably black out a typical city instantaneously. Societies may therefore be tempted to discourage disruption through stringent controls akin to a garrison state. In times of social stress, when grids become a likely target for dissidents, the sector may be paramilitarized and further isolated from grassroots politics.

If the technology used, like nuclear power, is subject to technical surprises and unique psychological handicaps, prudence or public clamor may require generic shutdowns in case of an unexpected type of malfunction: one may have to choose between turning off a country and persisting in potentially unsafe operation. Indeed, though many in the $100 billion quasi-civilian nuclear industry agree that it could be politically destroyed if a major accident occurred soon, few have considered the economic or political implications of putting at risk such a large fraction of societal capital. How far would governments go to protect against a threat—even a purely political threat—a basket full of such delicate, costly, and essential eggs? Already in individual nuclear plants, the cost of a shutdown—often many dollars a second—weighs heavily, perhaps too heavily, in operating and safety decisions.

Any demanding high technology tends to develop influential and dedicated constituencies of those who link its commercial success with both the public welfare and their own. Such sincerely held beliefs, peer pressures, and the harsh demands that the work itself places on time and energy all tend to discourage such people from acquiring a similarly thorough knowledge of alternative policies and the need to discuss them. Moreover, the money and talent invested in an electrical program tend to give it disproportionate influence in the counsels of government, often directly through staff swapping between policy- and mission-oriented agencies. This incestuous position, now well developed in most industrial countries, distorts both social and energy priorities in a lasting way that resists political remedy.

For all these reasons, if nuclear power were clean, safe, economic, assured of ample fuel, and socially benign per se, it would still be unattractive because of the political implications of the kind of energy economy it would lock us into. But fission technology also has unique sociopolitical side effects arising from the impact of human fallibility and malice on the persistently toxic and explosive materials in the fuel cycle. For example, discouraging nuclear violence and coercion requires some abrogation of civil liberties[34]; guarding long-lived wastes against geological or social contingencies implies some form of hierarchial social rigidity or homogeneity to insulate the technological priesthood from social turbulence; and making political decisions about nuclear hazards that are compulsory, remote from social experience, disputed, unknown, or unknowable may tempt governments to bypass democratic decision in favor of elitist technocracy.[35]

Even now, the inability of our political institutions to cope with nuclear hazard is straining both their competence and their prerceived legitimacy. There is no scientific basis for calculating the likelihood or the maximum long-term effects of nuclear mishaps, or for guaranteeing that those effects will not exceed a particular level; we know only that all precautions are, for fundamental reasons, inherently imperfect in essentially unknown degree. Reducing that imperfection would require much social engineering whose success would be speculative. Technical success in reducing the hazards would not reduce, and might enhance, the need for such social engineering. The most attractive political feature of soft technologies and conservation—the alternatives that will let us avoid these decisions and their high political costs—may be that, like motherhood, everyone is in favor of them.

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[34] R. Ayres, *Harvard Civil Rights—Civil Liberties Law Review 10*:369–443 (1975); J. H. Barton, "Intensified Nuclear Safeguards and Civil Liberties," report to USNRC, Stanford Law School, 21 October 1975; R. Grove-White and M. Flood, "Nuclear Prospects: A comment on the Individual, the State and Nuclear Power" (London: Friends of the Earth Ltd./Council for the Protection of Rural England/National Council for Civil Liberties, 27 October 1976).

[35] H. P. Green, *George Washington Law Review*, 43:791–807 (March 1975).

2.10. SOME DEEPER ISSUES

Civilization in the United States, according to some, would be inconceivable if people used only, say, half as much electricity as now. But that is what they did use in 1963, when they were at least half as civilized as now. What would life be like at the per capita levels of primary energy that Americans had in 1910 (about the present British level) but with doubled efficiency of energy use and with the important but not very energy-intensive amenities that people lacked in 1910, such as telecommunications and modern medicine? Could it not be at least as agreeable as life today? Since the energy needed today to produce a unit of GNP varies more than one hundred-fold depending on what goods or service is being produced, and since GNP in turn hardly measures social welfare, why must energy and welfare march forever in lockstep? Such questions today can be neither answered nor ignored.

Underlying energy choices are real but tacit choices of personal values. Those that make a high energy society work are all too apparent. Those that could sustain lifestyles of elegant frugality are not new; they are in the attic and could be dusted off and recycled. Such values as thrift, simplicity, diversity, neighborliness, humility, and craftsmanship—perhaps most closely preserved in politically conservative communities—are already, as we see from the ballot box and the census, embodied in a substantial social movement, camouflaged by its very pervasiveness. Offered the choice freely and equitably, many people would choose, as Herman Daly puts it, "growth in things that really count rather than in things that are merely counttable": choose not to transform, in Duane Elgin's phase, "a rational concern for material well-being into an obsessive concern for unconscionable levels of material consumption."

Indeed, we are learning that many of the things we had taken to be the benefits of affluence are really remedial costs, incurred in the pursuit of benefits that might be obtainable in other ways without those costs. Thus much of our prized personal mobility is really involuntary traffic made necessary by the settlement patterns that cars create. Is that traffic a cost or a benefit?

Pricked by such doubts, our inflated craving for consumer ephemerals is giving way to a search for both personal and public purpose, to reexamination of the legitimacy of the industrial ethic. In the new age of scarcity, our ingenious strivings to substitute abstract (therefore limitless) wants for concrete (therefore reasonably bounded) needs no longer seem so virtuous. But where we used to accept unquestioningly the facile, and often self-serving, argument that traditional economic growth is essential for distributional equity, new moral and human stirrings now are nudging us. We can now ask whether we are not already so wealthy that further growth, far from being essential to addressing our equity problems, is instead an excuse not to mobilize the compassion and commitment that could solve the same problems with or without the growth.

Finally, as national purpose and trust in institutions diminish, governments, striving to halt the drift, seek ever more outward control. We are becoming more uneasily aware of the nascent risk of what a Stanford Research Institute group, quoting Bertram Gross, has called

". . . 'friendly fascism'—a managed society which rules by a faceless and widely dispersed complex of warfare-welfare-industrial-communications-police bureaucracies with a technocratic ideology." In the sphere of politics as of personal values, could many strands of observable social change be converging on a profound cultural transformation whose implications we can only vaguely sense: one in which energy policy, as an integrating principle, could be catalytic?[38]

It is not my purpose here to resolve such questions—only to stress their relevance. Though fuzzy and unscientific, they are the beginning and end of any energy policy. Making values explicit is essential to preserving a society in which diversity of values can flourish: an end that a soft energy path seems better suited to serve.

Some people suppose that a soft energy path entails mainly social problems, a hard path mainly technical problems, so that since in the past we have been better at solving the technical problems, that is the kind we should prefer to incur now. But the hard path, too, involves difficult social problems. We can no longer escape them; we must choose which kinds of social problems we want. The most important, difficult, and neglected questions of energy strategy are not mainly technical or economic but rather social and ethical. They will pose a supreme challenge to the adaptability of democratic institutions and to the vitality of our spiritual life.

2.11. EXCLUSIVITY

These choices may seem abstract, but they are sharp, imminent, and practical. We stand at a crossroads: without decisive action our options will slip away. Delay in energy conservation lets wasteful use run on so far that the logistical problems of catching up become insuperable. Delay in widely deploying diverse soft technologies pushes them so far into the future that any credible fossil fuel bridge to them has been burned: they must be well under way before the worst part of the oil and gas decline. Delay in building the fossil fuel bridge makes it too tenuous: what the sophisticated coal technologies can give us, in particular, will no longer mesh with our pattern of transitional needs as oil and gas dwindle.

Yet these kinds of delay are exactly what we can expect if we continue to devote so much money, time, skill, fuel, and political will to the hard technologies that are so demanding of them. Enterprises like nuclear power are not only unnecessary but a positive encumbrance, for they prevent us, through logistical competition and through cultural and institutional incompatibility, from pursuing the tasks of a soft path at a high enough priority to make them work together properly. A hard path can make the attainment of a soft path prohibitively difficult in three ways: by starving its components into garbled and incoherent fragments; by changing social values and perceptions in a way that makes the innovations of a soft path more painful to envisage; and by evolving institutions, policy actions, and political commitments in a way that inhibits those same innovations. Though soft and hard paths are not *technically* incompatible—reactors and solar collectors could in principle coexist—the two paths are antagonistic in other and more important ways that, though qualitative and judgmental, are real and unavoidable. As nations, therefore, we must choose one path before they diverge much further. Indeed, one of the infinite variations on a soft path seems inevitable, either smoothly by choice now or disruptively by necessity later; and I fear that if we do not make the choice, growing tensions between rich and poor countries may destroy the conditions that now make smooth attainment of a soft path possible.

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[38] W. W. Harman, *An Incomplete Guide to the Future* (Palo Alto, California: Stanford Alumni Association, 1976).

These conditions will not be repeated. Some people think we can use oil and gas to bridge to a coal and fission economy, then use that later, if we wish, to bridge to similarly costly technologies in the hazy future. But what if the bridge we are now on is the last one? Our past major transitions in energy supply were smooth because we subsidized them with cheap fossil fuels. Now our new energy supplies are ten or a hundred times more capital-intensive and will stay that way. If our future capital is generated by economic activity fueled by synthetic gas at $30 a barrel equivalent, nuclear electricity at $60—120 a barrel equivalent, and the like, and if the energy sector itself requires much of that capital just to maintain itself, will capital still be as cheap and plentiful as it is now, or will we have fallen into a "capital trap"? Wherever we make our present transition to, once we arrive we may be stuck there for a long time. Thus if neither the soft nor the hard path were preferable on cost or other grounds, we would still be wise to use our remaining cheap fossil fuels—sparingly—to finance a transition as nearly as possible straight to our ultimate energy income sources. We shall not have another chance to get there.

MULTIPLE PATHS FOR ENERGY POLICIES: A CRITIQUE OF LOVINS' ENERGY STRATEGY

(By Harry Perry and Sally H. Streiter)*

INTRODUCTION

In a widely read article published in *Foreign Affairs* last October,[1] Amory Lovins proposed that the high technology or "hard" path to energy supply on which the United States seemed to be set was the wrong path. It was wrong because it would lead to nuclear proliferation and the end of the world, because it induced inappropriate cultural values and, anyway, it was too expensive. Another path was open, he proposed, and the paths were mutually exclusive. His path would involve, first, conservation, through the use of insulation, redesign of engines, furnaces and other appliances, reuse of waste heat through cogeneration, and redesign of buildings. This could reduce energy demand over the next fifty years to below the current level while maintaining standards of living. The reduced demand would then be filled by renewable energy sources, namely solar energy and biomass conversion with a little windpower thrown in. To get us over the hump (demand rises 30 percent between now and 2000 in Lovins' scenario, before falling off again in 2025), coal could be used in fluidized beds, but not to generate incremental electricity. Nor would he use solar energy to generate electricity. In fact, electricity is the chief villain, led by nuclear which he would like to see banned.

Lovins' critics have generally gone after his numbers without too much success; indeed, in a very public discussion, Nobel laureate Hans Bethe conceded that he had been mistaken about the potential of solar heating. We have reviewed in Section III of this paper the current status of some of the technologies he proposes, and conclude that while many of them are actually or potentially feasible in a technical sense, their introduction has been thus far delayed because they have been uneconomic. Changes in the price of the fossil fuels clearly render at least some of them more economic, but not so clearly superior as to warrant a "dirigiste autocratic" approach (to borrow a phrase) to divert the economy exclusively into soft technologies. The basic supply question that remains unanswered and unanswerable today is what the supply schedule looks like. Even the prices quoted by Lovins for current delivery are very soft, for which we cannot really fault him, but the costs of mass production and the time involved for new technologies to take hold are not at all clear.

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*Published by National Economic Research Associates, Inc. (NERA), 1977. Harry Perry and Sally H. Streiter are Senior Consultants at NERA. Reprinted by permission.

[1] A. B. Lovins, "Energy Strategy: The Road Not Taken?" Foreign Affairs, Vol. 55, No. 1 (October 1976), pp. 65–96.

Will solar technology be like the hand-held calculator, improving with volume and getting cheaper by the week, or will it be like the nuclear industry where the early models were cheap and bottlenecks in supply of labor and materials drove the price up? Aluminum and plate glass, the raw materials for solar collectors, are heavily dependent on electricity and natural gas in their production, and there are good reasons to suppose that incremental energy supplies to these industries will be substantially more costly than historic sources, driving up the price of solar as production increases. Biomass takes land—what will happen to the price of land if a biomass industry grows up to half the size of all current agricultural production?

The potential speed of introduction and eventual market share of the soft technologies has not yet been fully explored, but there is a wide disparity between Lovins' and other estimates of the market share potential of soft technologies. ERDA's estimates suggest 7 to 10 quads by 2000 [2] for soft technologies, whereas Lovins goes for 32 quads.

On the demand side, we have examined the various projections for energy consumption in the year 2000, most of which are considerably higher than Lovins' 95-quad scenario. We agree with him that the lockstep GNP energy hypothesis is faulty, and that there is considerable potential for dampening demand through conservation measures which are economically justified. However, we believe Lovins has overlooked a subtle point which is totally damaging to his estimate. We explain further in Section II. He has assumed that doubling energy efficiency will halve demand, whereas the effect will be also of halving the price and, if there is any demand elasticity, the full savings will not be gained. We therefore conclude that his demand scenario for 2000 has underestimated increases in demand over 1976.

Before launching into the numbers, however, we have tried to tackle the area most of Lovins' critics have avoided; we have endeavored to take his social policy arguments as seriously as he evidently does and consider their meaning and merits. We turn to this now in Section 1.

I. ENERGY DELIVERY SYSTEMS AND SOCIAL VALUES

> In the sphere of politics a sof personal values, could many strands of observable social change be converging on a profound cultural transformation whose implications we can only vaguely sense; one in which energy policy, as an integrating principle, could be catalytic? [3]

> The first path is convincingly familiar, but the economic and sociopolitical problems lying ahead loom large, and eventually, perhaps insuperable. The second path . . . offers many social, economic and geopolitical advantages, including virtual elimination of nuclear proliferation from the world. [4]

Amory Lovins is a consultant physicist but his main message is that of a social physician. Although criticisms of his work have tended to center on the strategies he proposes, their costs, benefits and feasibility, they have by and large ignored the main message. Yet it is a message which in various forms is receiving increasing acceptance in widely disparate areas of social policy. In education, in health, and now in energy, a line of criticism is emerging which runs as follows: "What you are doing does not work. You are not managing to do even what you say you want to do. You are pouring resources into the wrong things. There are other and better ways, which you are not even considering. I think they are better because they will lead to a social organization I prefer. You, however, can reject my values but not my proposals because my proposals meet *your* test which is that they are more economic."

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[2] U.S. Energy Research and Development Administration, A National Plan for Energy Research, Development and Demonstration, Creating Energy Choices for the Future, Vol. 1 (Washington, D.C.: U.S. Government Printing Office, 1976), p. B-6.

[3] Lovins, "Energy Strategy," p. 95.

[4] Lovins, "Energy Strategy," p. 85.

The radicals are not talking basically about tinkering on the edges of policy. Lovins—despite all the critics who to a man would like to see his soft energy proposals receive more research funds and be incorporated into the system where appropriate—holds fast to the view that there are two mutually exclusive paths. Charles Reich's popular book, *The Greening of America*, was based on the belief that opposition to the Vietnam War and development of a popular counterculture would truly revolutionize society. Lovins' vision perceives energy as the ideal catalyst to revolutionize the world.

The father of this approach to major changes in national priorities is Ivan Illich,[5] who has turned his prolific pen on many sacred cows. In education, his theme is to "deschool society"—he holds that pouring more teachers and more classrooms into the development of our children does harm, not good. Massive increases in education budgets have not even raised reading scores, and although Illich would not consider a reading score a useful test, his point is that the aim of the education system seems to be to produce reading scores and it cannot even do that. Thoughtful people in education report that, even if they do not share Illich's social values, they cannot deny his conclusion that "budget expansion has not been the panacea they had hoped."

In health, the same sort of criticism is current. Medical care costs are growing faster than any other item in the economy, consuming 8.6 pecent[6] of the U.S. Gross National Product. This is a higher proportion than any other country, yet the U.S. health indices compare unfavorably with those of other developed countries in terms of such measures as infant mortality and even life expectancy. The critics of the health care system suggest that its goals and methods are wrong: that there is an overemphasis on the more dramatic and costly forms of intervention and too little on the basic forms of prevention and care which affect many more people and are relatively cheap.

Even the rhetoric is the same (and note, this is the Director General of the World Health Organization, not a maverick critic).

> The director general of the World Health Organization today [May 3, 1977] urged the breaking of what he termed the 'claims of dependence on unproved, oversophisticated and overcostly health technology.'
>
> In a keynote address to the annual assembly of the 150-nation agency, Dr. Halfdan Mahler called for a technology that was 'more appropriate because it is technically sound, culturally acceptable and financially feasible.'[7]

Compare this with Lovins:

> [The soft energy path,] besides having much lower and more stable operating costs than the hard path . . . appears generally more flexible. . . . Its technical

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[5] See for example, I. Illich, Tools for Conviviality (New York, Harper & Row, 1973).
[6] Congressional Research Service, 1976 figures.
[7] "W.H.O. Chief Criticizes Costly Health Technology and Urges Replacement," The New York Times (May 4, 1977), p. A-13.

> diversity, adaptability, and geographic disperson make it resilient . . . [and] ideally suited for rural villages and urban poor alike. . . . Soft technologies do not carry with them inappropriate cultural patterns or values . . .[8]

When this line of argument is applied to energy delivery systems, it is tempting, though foolish, to ignore it. It is in large measure foreign to the thought of those of us who reason in equations or see the market system as arbitrating our various wants and needs in a rational manner. In our terms, the critics are arguing that there are massive externalities and grossly imperfect markets. Lovins does indeed argue for rational pricing of energy, for long-run marginal costs, and asserts that, if the paraphernalia of regulation, subsidization and controls were working properly, then that would be a first step to introducing his program which is "more economic." It is hard to argue against the idea that 52¢ natural gas made insulation relatively unattractive, or that price controls on oil have contributed to our international vulnerability.

However, tempting as it is to revert to familiar territory, we leave analysis of the economics of his proposal until later in this paper. For the message is also, very clearly, my way would be better even if it were not economic.

> If it [a 100-percent solar system] cost more [than a nuclear and heat-pump system], there would still be good reasons to use it anyway; but its being cheaper makes a neater argument for people who value narrow economic rationality above unemployment, inflation, centrism, vulnerability, proliferation, and other concomitants of the nuclear option.[9]

What are the societal values which Lovins and his co-physicians are advocating?

A. Nuclear Proliferation and Its International Implications

First, Lovins' message is that a domestic nuclear program encourages international nuclear proliferation. "We must soon choose one [path] or the other—before failure to stop nuclear proliferation has foreclosed both."[10] How reasonable is his stance on proliferation?

Those who oppose nuclear power domestically frequently stress the international implications and the relationship of commercial nuclear power to weapons proliferation. The linkage is real and the problem enormous, yet the solution is not as easy as Lovins would like us to believe.

The linkage comes about through two mechanisms, people and materials. Nuclear reactor technology requires a substantial cadre of trained people for its operation, and those same people, once they know [illegible] nuclear power, also have sufficient knowledge to make nuclear [illegible] Second, light water nuclear reactors both consume and produce [illegible]terial—enriched uranium and plutonium, respectively. While this [illegible]ssile material is presently covered by international safeguards [particularly provisions of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) which is enforced by the International Atomic Energy Agency (IAEA)], the safeguards are not foolproof and not all reactors are subject to them. France, South Africa and Brazil, for instance, refused to ratify the NPT.[11] Furthermore, some small research reactors are not subject to the safeguards.[12] It was a small research reactor that India used to manufacture its bomb,[13] and estimates of Israel's nuclear weapons capability are routinely based on the plutonium-producing capacity of its research reactor at Dimona.[14]

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[8] Lovins, "Energy Strategy," pp. 87–89.

[9] A. B. Lovins, "Comment and Correspondence," Foreign Affairs, Vol. 55, No. 3 (April 1977), p. 639.

[10] Lovins, "Energy Strategy," p. 66.

The reactor-bomb linkage is sufficient but not necessary. Reactors are not the only route to bombs. Countries can acquire the knowledge necessary for weapons without training a cadre of commercial reactor specialists; in fact, the information is relatively easy to obtain. On the materials side, the reactor linkage is clearer: a commercial reactor program makes access to weapons-grade materials dramatically easier. While it is not a particularly attractive direct route toward obtaining weapons, its existence provides a country with the opportunity at almost any time to extract large amounts of plutonium from spent fuel, should it decide to do so.

Only highly enriched uranium and plutonium are suitable for the construction of nuclear weapons. Because the former is still a product of highly advanced and relatively expensive technology, the control of the access to highly enriched uranium has been relatively simple. Nuclear fuel itself does not provide the necessary uranium since light water reactors are fueled with low enriched uranium (about 3 percent U_{235}) rather than the highly enriched uranium (about 90 percent U_{235}) required for the production of nuclear weapons. Therefore the construction of nuclear weapons using highly enriched uranium requires a country to make substantial economic and technical investments in enrichment technology. While the uranium route could be facilitated with the advent of laser isotope separation,[15] at least with current technology, the direct enriched uranium route to nuclear weapons remains particularly unattractive.

To date, the United States has exported very limited amounts of highly enriched uranium and has refused to export the enrichment process itself.[16] Together with the Soviet Union, the U.S. now maintains a virtual monopoly on the supply of enriched uranium to reactors in the western countries today. However, by the mid-1980s, about ten countries are expected to possess enrichment facilities built in conjunction with their commercial reactor programs.[17] This, together with the expected laser technology for uranium enrichment, will greatly increase the potential access to facilities that could conceivably be utilized to produce highly enriched uranium for weapons use.

At the present time, the critical factor in the proliferation problem is plutonium. Plutonium is produced as a by-product of nuclear fission in a commercial reactor and, if separated and accumulated can be fashioned into a relatively inefficient but still deadly nuclear weapon. The separation of plutonium from spent reactor fuel requires a relatively simple and inexpensive chemical process which is within reach of most of the countries that are now building commercial reactors. As a result, a country with commercial reactors and spent fuel will generally be in a position to relatively quickly and easily extract the plutonium required for nuclear weapons. For these countries, the roadblock to nuclear weapons is not technical, but political, including the Nuclear Nonproliferation Treaty, IAEA safeguards, bilateral safeguards and the general political and security implications of a particular country's decision to build a bomb.

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[11] J. A. Yager and E. B. Steinberg, eds., Energy and U.S. Foreign Policy, "A Report to the Energy Policy Project of the Ford Foundation" (Cambridge: Ballinger, 1974), p. 375.

[12] Yager and Steinberg, Energy and U.S. Foreign Policy, p. 375.

[13] J. R. Lamarsh, "On the Construction of Plutonium-Producing Reactors by Small and/or Developing Nations," April 30, 1976, Report for the Congressional Record, Hearings for S. 1439: Export Reorganization Act of 1976 (Washington, D.C.: U.S. Government Printing Office, 1976), p. 367.

[14] "Senate Unit Is Divided on Terms of Nuclear Reactor Sale to Israel," The New York Times (June 21, 1977), p. 8.

[15] A. S. Krass, "Laser Enrichment of Uranium: The Proliferation Connection," Science, Vol. 196, No. 4291 (May 13, 1977), pp. 721–31.

[16] W. W. Lowrance, "Nuclear Futures for Sale: To Brazil from West Germany, 1975," International Security, Vol. 1, No. 2 (Fall 1976), p. 153.

[17] P. L. Joskow, "The International Nuclear Industry Today, The End of the American Monopoly," Foreign Affairs, Vol. 54, No. 4 (July 1976), p. 796.

Indeed, the plutonium route does not even require commercial reactors. A country could produce a relatively crude plutonium-producing reactor using natural uranium and other materials over which there are few, if any, international controls[18] and a simple reprocessing plant for extracting the plutonium.

Almost no one who has thought about or investigated the topic would deny that here is a very, very big problem. President Carter has proposed an indefinite postponement of plutonium recycling for commercial purposes and a ban on U.S. exports of plutonium reprocessing plants.[19] U.S. supplies of uranium seem to be sufficient to permit light water reactors to function without reuse of the plutonium as a fuel for at least the next twenty years, and although there are some disputes about the economics of reprocessing, the balance of opinion seems to be that using plutonium does not make economic sense in the U.S. at present anyway. Carter has postponed the construction of the plutonium-fueled breeder reactor at Clinch River indefinitely, citing the dangers of plutonium and the potential availability of thorium as a breeder fuel, although the feasibility of thorium is not clear.[20] Therefore, current U.S. policy can be summarized as follows:

Minimize the availability of plutonium abroad, by discouraging reprocessing: the assertion that it is not economic anyhow is made more believable by a domestic posture postponing plutonium recycling and the plutonium breeder.

Do not give countries an incentive to develop their own front-end and back-end facilities: the policy here is to guuarantee a stable and low cost supply of enrichment services and to provide storage facilities for spent fuel that is not reprocessed.

Lovins concludes that the way to solve the problem is to "phase out [the U.S.] nuclear power program and its support of others' nuclear power programs."[21] This neglects the realities of the world market for nuclear reactors. The once near monopoly position of the U.S. in world reactor sales has been rapidly eroded by other industrialized countries such as France, West Germany and Canada.[22] Any effort to effectively control the sale of reactors and reactor technology requires the cooperation of a fairly large number of industrial countries. In fact, these countries have been meeting regularly to develop safeguards and export controls to limit the proliferation potential of commercial reactor sales.[23] Unilateral efforts by the U.S. to phase out its nuclear program, restrict access to low enriched uranium, or ban the sale of commercial reactors are likely to be counter-productive in the long run.[24] By taking the proliferation problem seriously, the U.S. has been able to use the economic and political leverage that it does have to upgrade safeguard guarantees and to convince other countries to agree not to export additional enrichment and reprocessing technology to countries like Brazil and Pakistan. Germany, France and other countries have all apparently agreed on this point (although prior sales to Brazil and Pakistan will apparently go forward.)

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[18] Yager and Steinberg, Energy and U.S. Foreign Policy, p. 377.

[19] "U.S. Ready to Cease Push for Plutonium as Fuel in Reactors," The New York Times (April 7, 1977), pp. A-1, D-7.

[20] H. A. Feiveson and T. B. Taylor, "Security Implications of Alternative Fission Futures," Bulletin of the Atomic Scientists (December 1976), pp. 14-17.

[21] Lovins, "Energy Strategy," p. 90.

[22] Joskow, "The International Nuclear Industry," pp. 792-95.

An interesting solution to the problems of proliferation and inadequate controls—a market-sharing cartel—was recently proposed by Senator Ribicoff.[25] First Ribicoff would reduce the competition to sell reactors (which he views as the crux of the nuclear problem) by allocating a *pro rata* share of the market to supplier countries, based upon their productive capacities. All orders would be filed with the IAEA and placed on the basis of agreed-upon minimum sales for each supplier.

Second, the spent fuel problem could be solved if fuel enrichment, reprocessing and fabrication were concentrated in large, multinational, IAEA-controlled plants. Under this agreement, uranium enrichment services would be provided to customer nations as a credit for the plutonium contained in the spent fuel which the members deposited. Ribicoff believes that, under such a system, economies of scale and reliability of supply could be assured. The main problem he foresees is convincing France and West Germany to agree not to export the elements of the fuel cycle. Although both France and West Germany now have uranium enrichment technologies, large-scale production will not begin for several years and they are dependent meanwhile on U.S. enriched uranium for their own domestic reactors. Ribicoff sees this as a pressure point to force agreement.[26] Such an approach now seems unnecessary since these countries have agreed not to export additional critical fuel cycle facilities and have severely tightened bilateral safeguard requirements.

In the end, the proliferation problem is only partially a function of access to a complete commercial fuel cycle. Germany, Japan, Canada, etc. could have developed nuclear weapons long ago. They have not because they perceived that such development might actually reduce their security rather than increase it. Controls over the commercial fuel cycle must continue to be supplemented by other security guarantees which make it unattractive for a country to want to develop nuclear weapons in the first place. Whether countries like South Korea, Taiwan, Israel, South Africa, etc. develop nuclear weapons depends much more on whether credible defense alliances with the U.S. continue, than it does on the existence of a commercial nuclear energy industry.

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[23] For example, in the recent London Suppliers Group meetings, representatives from 15 countries with nuclear industries convened for the specific purpose of establishing rules to curb the nuclear spread.

[24] N. Hawkes, "Carter Nuclear Policy Finds Few Friends," Science, Vol. 196, No. 4294 (June 3, 1977), p. 1062.

[25] A. A. Ribicoff, "A Market-Sharing Approach to the World Nuclear Sales Program," Foreign Affairs, Vol. 54, No. 4 (July 1976), pp. 764–87.

[26] This seems to be the policy Carter was following prior to the London talks with European leaders in May.

The burden of nonproliferation cannot be put on the commercial nuclear energy industries completely. Export policies, economic incentives to stay away from critical fuel cycle facilities, and safeguards can reduce the probability that a country will suddenly enter the nuclear weapons club. But such policies are only adjuncts to overall international defense and mutual security programs. Pakistan probably wants the opportunity to develop a bomb because it does not perceive existing security guarantees as adequate in the face of Indian military capabilities; the Brazilians and the Argentinians probably feel somewhat the same.[27] Far too much of the burden of the proliferation problem has been placed on commercial nuclear power programs and far too little on the basic economic, social and political institutions that create the incentives for nations and subnational groups to acquire nuclear weapons.

We agree that Lovins has identified an important problem. But his solution simply will not work. Improved international political institutions for minimizing the risk of proliferation are certainly called for. The U.S. has the power to take the lead in negotiating international agreements that will serve to minimize the risks that additional countries will either want to or be easily able to develop nuclear weapons. But unilateral U.S. action cannot eliminate the risk of proliferation and it might even increase it.

A source close to the SALT talks puts it as follows: there are basically two views about proliferation. The first is that it is a disaster, the world is likely to blow up, but you can't stop it. This was essentially the private view of the Nixon/Ford administration. The second is that it is a disaster, the world is likely to blow up, but you can stop it. This is essentially the view of Carter and Vance. Many serious observers believe that it is perhaps the ultimate question, but apart from the superdoves, no one thinks the answers are easy.

E. Hard Energy Determinism and Soft Energy Pluralism

Lovins' second message is that our present energy delivery system is all-pervasive and controlling.

> . . . [T]he kinds of social change needed for a hard path are apt to be much less pleasant, less plausible, less compatible with social diversity and personal freedom of choice, and less consistent with traditional values than are the social changes that could make a soft path work.
>
> While soft technologies can match any settlement pattern, their diversity reflecting our own pluralism, centralized energy sources encourage industrial clustering and urbanization . . . [and] allocate benefits to suburbanites and social costs to politically weaker rural agrarians. Siting big energy systems pits central authority against local autonomy in an increasingly divisive and wasteful form of centrifugal politics. . . .[28]

Lovins has reiterated several times in his writing that "low energy futures can (but need not) be normative and pluralistic, whereas high energy futures are bound to be coercive and to offer less scope for social diversity and individual freedom." This basic theme can be examined in two parts.

First, Lovins suggests a close linkage between social organization and energy supply systems. Alvin Weinberg has questioned the deterministic implications of this viewpoint.

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[27] "Drive Against Nuclear Spread Focuses on 12 Nations," The New York Times (May 17, 1977), p. 3.

[28] Lovins, "Energy Strategy," pp. 91-92.

> Indeed, the tie between energy intensity, bureaucracy, and centralization, which is so prevalent a theme among the anti-energy intellectuals, is largely a mystery to me. There are many factors in our modern society that encourage bureaucratization, centralization, and vulnerability, and I would think that energy and how we generate it are hardly the most important. For example, the technologies of mass communication are probably far more significant potential sources of malign centralization than are the technologies of energy generation: Hitler was much more the product of radio than he was of central electricity.[29]

It is hard to improve on Weinberg's comment, for it is really difficult to see how electricity dictates social organization.

Others such as E. J. Mishan[30] have argued that economic growth and/or the automobile are responsible for the decline in neighborliness and civility, which Lovins abhors, while Illich would probably cast the blame on industrial civilization. Indeed, the main villain of Illich's diatribe on energy is the automobile and the highway system.

> The typical American male devotes more than 1,600 hours a year to his car. He sits in it while it goes and while it stands idling. He parks it and searches for it. He earns the money to put down on it and to meet the monthly installments. He works to pay for petrol, tolls, insurance, taxes and tickets. He spends four of his sixteen waking hours on the road or gathering his resources for it. And this figure does not take into account the time consumed by other activities dictated by transport: time spent in hospitals, traffic courts and garages; time spent watching automobile commercials or attending consumer education meetings to improve the quality of the next buy. The model American puts in 1,600 hours to get 7,500 miles: less than five miles per hour. In countries deprived of a transportation industry, people manage to do the same, walking wherever they want to go.[31]

Illich would not argue that people did not freely choose to love their automobiles, only that they were heavily influenced in doing so by free roads and by advertising and that the externalities in terms of loss of neighborliness and isolation were not readily perceived.

It is, however, difficult to make the same connection between electricity and social organization, unless perhaps one has in mind television and its effects on family life. Centralized energy sources are bad, we are told, because they "encourage industrial clustering and urbanization." But the chief complaint against the car was that it encourages suburbanization and isolation! The connecting argument seems to be that scale economies in electricity make large-scale energy supply systems inevitable, and require highly specialized (and therefore "remote") people to run them, whereas soft energy systems are more directly attached to the people who use them.

At one level, this appears to be obviously true, although not obviously undesirable. At another level, it is not quite as true as it seems. The combustion of coal in a fluidized-bed system takes place in the consumer's own home: the combustion of coal to produce electricity takes place far from him. Yet the coal mine is still required and the transportation network for coal delivery would surely rival the complexities of the electric distribution system. Similarly, a solar collector is placed on a building and is therefore "local." But the aluminium and plate glass industries standing behind the collector are as far away and remote and technically complex as the generating station. One might also add that they are highly centralized industries. In

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[29] A. Weinberg, "Book Review: Non-Nuclear Futures: The Case for an Ethical Energy Strategy," July 27, 1976 (for publication in Energy Policy), p. [illegible]

[30] E. J. Mishan, The Costs of Economic Growth (London: Staples Press, 1967).

[31] I. Illich, Energy and Equity (New York: Harper & Row, 1974), pp. 18–19.

1972, for example, the concentration ratio for the top four companies in the plate and float glass industry was 91 percent and for the top four primary aluminum producers, 80 percent.[32]

The advocates of solar energy might also be well advised to remember the fate of early heat pumps, which were killed by lack of local knowledge and standardization, and press hard for "bureaucratic and centralized" decisions to eliminate fly-by-night local contractors and the indignity of $12,000 solar roof installations that leak and crack. Solar energy will give each individual more control of his own destiny, presumably until the friendly local solar engineers become less available to fix the leaking collector than the friendly local utility is to fix the distribution outage.

Again, biomass conversion, which is Lovins' chief answer to liquid fuel supply, would take, he tells us, ten times the current U.S. brewery capacity. It is not clear that this is likely to show fewer economies of scale and less concentration than refineries, especially given the transportation problems associated with the light and bulky initial product.

It is possible to argue on many grounds that pluralism, dispersion of power and decentralization of economic decision-making are desirable things; indeed, many economists would argue that democracy is enhanced by consumers making their own economic choices among alternative products, rather than a single four-year choice between alternative politicians who then make choices for them. At some points, Lovins seems almost to argue that a *highly centralized* decision be made to progress along the soft path. There is no real need for this. The very character of the soft path is that it need not be adopted in its entirety. If the soft technologies prove economic, then they can be phased in, their very virtues of flexibility permitting their gradual adoption. Nor is the hard path so inflexible that it could not be phased out if it turns out to be desirable to do so. The effort to resolve the false dichotomy raised by Lovins seems to be more antithetical to pluralism than a less radical policy which, by pricing sensibly, encourages new technologies and removes market barriers.

Perhaps what Lovins is really getting at is the nuclear argument again. He argues that the safety risks of nuclear are unacceptable to present and future generations.

> Governments should suspend their nuclear programs, until enough infallible people can be found to operate them for the next few hundred thousand years and until all those affected by such programs have been consulted (which may present technical difficulties).[33]

In fact, Lovins' hostility to nuclear power is less obvious in his *Foreign Affairs* article than in his other writings cited in the references. His efforts on behalf of soft energy futures are, to a very considerable extent, efforts to first politicize and then outlaw nuclear.

Lovins suggests society cannot handle the nuclear genie. This will, of course, remain moot regardless of any intellectual arguments that could be raised, but serious efforts have been made to evaluate the social effects of nuclear power.[34] The Ford Foundation's Energy Policy

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[32] U.S. Bureau of the Census, 1972 Census of Manufacturers, Concentration Ratios in Manufacturing, Tables 6 and 7.

[33] A. B. Lovins, World Energy Strategies: Facts, Issues and Options (Cambridge: Ballinger, 1975), p. 126.

[34] See, for example, C. Hohenemser, R. Kasperson and R. Kates, "The Distrust of Nuclear Power," Science, Vol. 196, No. 4285 (April 1, 1977), pp. 25–34.

Study Group was set up in 1975 in the belief that the nuclear debate was poorly structured and undisciplined: the ground rules were that the participants be not only highly technically qualified but also open-minded. An unusually distinguished group of twenty one people grappled with most of the problems raised by the critics of nuclear power, including the soft arguments raised by Lovins and others, and recently published its 400-page report.

> On the issue of health effects of nuclear power, the group concluded that "the adverse health effects of nuclear power are less than or within the range of health effects from coal" and that [nuclear wastes and plutonium can be disposed of permanently in a safe manner. If properly buried deep underground in geologically stable formations, there is little chance that these materials will reenter the environment in dangerous quantities. Even if material were somehow to escape eventually in larger quantities than seems possible, it would not constitute a major catastrophe, or even a major health risk, for future civilizations.] [35]

This would not be sufficient to satisfy Lovins, who contends further that our civil liberties would be jeopardized by the requirement to guard the wastes against the threat of terrorism.

> . . . [I]f nuclear power were clean, safe, economic, assured of ample fuel, and socially benign per se, it would still be unattractive because of the political implications. . . . For example, discouraging nuclear violence and coercion requires some abrogation of civil liberties; guarding long-lived wastes against geological or social contingencies implies some form of hierarchical social rigidity or homogeneity to insulate the technological priesthood from social turbulence. . . .[36]

The Ford report concludes that the possibility of terrorism must be taken seriously, but that, as with airline hijacking, modest improvements in security could buy a substantial amount of protection. They recommend strengthening of physical security arrangements for nuclear facilities, but conclude that "improved security measures can be introduced without endangering civil liberties," [37] and note that while the NRC may soon require security clearance for 30,000 employees in the nuclear industry, this compares to 5 million persons already subject to security clearance.[38]

The Ford report is not the final word on these issues of values, which will continue to be debated for many years, but it does provide a substantial counterbalance to the gloomier views of Lovins.

A second strand of Lovins' domestic arguments in his championing of participatory democracy and local control.

In an electrical world, your lifeline comes not from an understandable neighborhood technology run by people you know who are at your own social level, but rather from an alien, remote, and perhaps humiliatingly uncontrollable technology run by a faraway, bureaucratized, technical elite who have probably never heard of you. Decisions about who shall have how much energy at what price also become centralized—a politically dangerous trend because it divides those who use energy from those who supply and regulate it.[39]

Lovins' energy democracy would appear to be characterized by high levels of informed public participation in energy decisions or the use of local elected representatives as a surrogate. Past political experience does not lend much enthusiasm for the level or effectiveness of public participation. For example, Nie and Verba report that widespread political activity "is found largely for those acts that are relatively easy" and "only a small minority of the citizenry is active beyond the act of voting."[40] Mitchell found that voter participation

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[35] Nuclear Power Issues and Choices. Report of the Nuclear Energy Policy Study Group. Sponsored by the Ford Foundation (Cambridge: Ballinger, 1977), pp. 19–20.

[36] Lovins, "Energy Strategy," p. 93.

[37] Nuclear Power Issues and Choices, p. 314.

[38] Nuclear Power Issues and Choices, p. 312.

[39] Lovins, "Energy Strategy," p. 92.

Number of political acts beyond the vote:	*Proportion active beyond the vote (percent)*
1	32
2	30
3	25
4	19
5	14
6±	13

> [i]n the general purpose units is much higher than in the special districts because citizens believe themselves to be more vitally affected by the traditional general governments than by the special districts providing mundane, if essential, services that private firms do not sell in the market—services such as fire protection, sewage disposal, park districts, etc.[41]

Is Lovins proposing new special energy districts to add to the present 80,000 units of governmental responsibility in the United States, which include some 21,000 special districts? Or, is he proposing to reorganize all political districts around the "central" energy theme?

Such local autonomy might also have its negative side. Water pollution control (sewage disposal) and air pollution control used to be local enterprises, but because of the effects of local decisions on the environments of neighboring jurisdictions, federal legislation has largely preempted local control. Education is also an essentially local enterprise, but the courts in various states have held that local funding discriminates against children in poor areas and have required a broader funding base. Lovins does not tell us whether he expects local control of energy to be funded by taxes or whether he simply wants local solar and insulation distributors to be smaller scale than local utilities; in fact, it is not absolutely clear what he does have in mind.

One could delve further into trying to understand what Lovins is trying to tell us about what he apparently believes to be the strong linkage between energy delivery systems and social organization. On the foreign side, we felt he had the right problem and a nonsolution; on the domestic side, we are tempted to conclude that he has a nonproblem.

II. DEMAND ASSUMPTIONS AND THE CONSERVATION POTENTIAL

Our efforts to examine the socio-political motivation of the Illich/Lovins/Schumacher school of energy critics leave us in a position where, although we may disagree, perhaps violently, with some of the premises, an alternative premise has been offered which forces us to examine the conclusions. The soft path is not only more "benign" and humanistic, it is cheaper.

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[40] N. H. Nie and S. Verba, "Political Participation" in Handbook of Political Science, Vol. 4, Nongovernmental Politics, ed. F. Greenstein and N. Polsby (Reading, Mass.; Addison-Wesley Publishing Co. 1975). The authors have calculated the proportions of the electorate acting beyond the vote as follows (p. 29).

[41] W. C. Mitchell, Why Vote? (Chicago: Markham Publishing Co., 1971). p. 136.

The "soft" path envisaged by Lovins is best seen in the alternative pictures of our energy future presented in his article. The "hard" way substitutes coal and nuclear power, via electrification, for most of the oil and gas, with a gross energy consumption of over 150 quads by 2000, 230 quads by 2025. The "soft" path reduces demand via conservation (which we examine below) to 95 quads in 2000 and a mere 60 quads in 2025, and fills it by 2000 with 32 quads of soft technology, the rest with oil, gas and coal; by 2025 the entire demand is met by soft technologies, with no nuclear, coal, oil, gas, or indeed, one gathers from the text, any electricity at all except existing hydroelectric resources.

What are these miraculous soft technologies? Their chief characteristic is that they "rely on renewable energy flows." (Lovins also waxes eloquent about them, asserting that they are "flexible, resilient, sustainable and benign." Well, but any utility president would say the same of electricity. Benignity is in the eye of the beholder.) Soft technologies are also characterized as matching end-use needs in scale, quality and geographic dispersion, a concept which he develops at some length.

But before the soft technologies fill the demand (which prospects we examine in Section III), the total demand has to be reduced by conservation. In this section, we examine other peoples' projections for energy demand in 2000; the relation between GNP and energy use; the concepts of gross and net demand; and the implications of conservation through efficiency on gross energy demand. We have not examined in detail the potential for conservation, but we note in passing that a recent study by Arthur D. Little[42] makes a persuasive case for the existence of virtually cost-free conservation through insulation in new buildings: savings of up to 60 percent in energy use are obtained using a design in which the extra initial costs of insulation are (in most cases) entirely offset by the reduced size and reduced initial cost of the heating, ventilating and air-conditioning systems required. The existence of this type of conservation potential is the foundation for the discussion of the effects of conservation on gross energy demand.

A. Projections and Scenarios

How plausible is Lovins' 95-quad scenario in total quantity and in mix? What do other serious students of the energy scene foresee?

Projections used to be done with a ruler. These projections, based on the 1960s, would have told us that overall energy use would grow 3.6 percent annually, for a year-2000 total of 177 quads. But rising energy prices have put an end to simple forecasts, so now we do complicated ones with computers instead of rulers. *Projections* make assumptions about prices, technology, population and GNP, and estimate consumption. *Scenarios* make assumptions about consumption and estimate what would be required in the way of prices, technology, population and GNP. It is desperately difficult to do either well. Even the Bureau of the Census offers three projections for the population growth rates: by the year 2000 the population may have increased 35 percent, or 16 percent, or something in between, say, 24 percent, over the 1974 level. Small wonder then that the energy forecasters, who were practically invented in the last decade, can do no better than the demographers who have been at it for years.

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[42] Energy Conservation in New Building Design, An Impact Assessment of ASHRAE Standard 90–75, PB–252 639, National Technical Information Service (Springfield, Virginia). A. D. Little Co., Inc. report to the U.S. Department of Commerce (March 1976).

There have been at least seven major studies of energy demand in the last three years. Their results, in terms of energy use in 1985, 2000 and various other years, are given in Table 1. The official projections of 1974 and 1975 do, as Lovins suggests, range mainly between 130–170 quads for 2000, although more recent studies come in with lower estimates. ERDA's combination case, which it uses as a projection, is 137 quads, reflecting a 2.5 percent annual growth, the same as the projected labor force growth.

B. GNP and Energy Use

Lovins accuses the official projections of assuming a close causal link between GNP and energy consumption and, in ERDA's case, this is true. The FEA and the Department of the Interior see little change if any in the assumed energy: GNP relation, which they put at 56 or 57 thousand Btu/GNP$ (1971 dollars). (See Table II.)

The main evidence that this linkage is not an inevitable lockstep comes from international data. Schipper's study of Sweden noted that "in 1971 the United States had a GNP per capita 10 percent higher than Sweden's at the then current exchange rates. However, for each dollar of GNP, Sweden required only 68 percent as much energy as the United States. Correcting for the energy embodied in foreign trade . . . reduces the 1971 Swedish figure to 61 percent."[43]

While the authors conclude that cultural, institutional, economic and technical factors all combine to reduce energy consumption, they stress the importance of prices. "The most important variable affecting energy use and energy efficiency is the relative price of energy with respect to other resources."[44] For example, gasoline has been nearly twice as expensive in Sweden as in the United States for many years, and Schipper shows per capita consumption of less than half the U.S. level in Sweden.[45] On the other hand, the mean price of electricity was similar in both countries and consumption levels were almost equal.

More recently, a study by Darmstadter, Dunkerley and Alterman for Resources for the Future compared energy consumption patterns for nine industrialized countries and found that, with the exception of Canada, the energy: GNP ratio was lower, ranging from 54 percent of the U.S. level in France to 86 percent of the U.S. level in the Netherlands. This is at least partly due to differences in geography, existing social infrastructure and taste as well as prices, and the authors warn against using the study to argue uncritically for emulation of the energy styles of the Europeans.

> [T]here are practical limits to the opportunities for instituting foreign-inspired energy husbandry in the United States. The United States is not about to acquire the population density of Japan, the geographic compactness of Germany, nor—very likely—the rail network of France, so that in the best of circumstances, some intercountry energy/GDP variability is bound to endure because of historical or deeply rooted reasons . . ."[46]

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[43] L. Schipper and A. Lichtenberg, "Efficient Energy Use and Well-Being: The Swedish Example," Science, Vol. 194, No. 4269 (December 3, 1976) pp. 1003–1004.

[44] Schipper and Lichtenberg, "Efficient Energy Use," p. 1012.

[45] Schipper and Lichtenberg, "Efficient Energy Use," Table 3, p. 1003.

[46] J. Darmstadter, J. Dunkerley and J. Alterman, "How Industrial Societies Use Energy: A Comparative Analysis," Preliminary report of a study prepared by Resources for the Future and financed by the Electric Power Research Institute (April 1977), pp. 33–34.

Clearly then it is impossible to argue a lockstep GNP: energy relationship in absolute terms. Countries can and do vary in the energy content of their GNP.

Within a single country, however, given the geography and social infrastructure, one might perhaps expect the energy: GNP ratio to be more stable. An analysis done by Shew for NERA showed an unmistakable decline over the period 1947–73 in energy intensity of GNP in the United States associated with rising per capita income, although he observes that in general, international comparisons show an overall association between energy use and per capita income. He suggests that this may be due to disparities in the range of data.

> [T]he income range of the post-war U.S. data is less than a quarter of the range of international per capita income observed. If energy intensiveness of output first rises with per capita GNP, as a consequence of increasing industrialization, and then declines, as service industries assume a larger role in output, this apparent discrepancy might be explained.[67]

We can probably reject, with Lovins, the *lockstep* energy: GNP argument and, in common sense terms, it would be surprising if it were otherwise. Energy as a factor of production will presumably be substituted for labor while it is cheap, and less so when it is expensive. If energy has been cheap relative to labor costs in the U.S., one would expect to find more energy-intensive production methods. Energy as a consumption item will be substitutable for every other type of consumption, the tradeoff depending on the price. If Swedes choose to buy other things than energy, it should hardly surprise us, particularly since gasoline, for instance, is priced at $1.35 per gallon. It would not surprise us if the Swedes found cheese more to their liking than beef, especially if beef were $5 per pound.

C. Gross and Net Energy

It does not make much sense to expect that *gross* energy use should be related to anything very much. What interests us, or what should interest us, is the work we get out of energy. People want warm houses and miles traveled, not gallons of distillate or gasoline. If technologies change, we may well be able to extract more work (or *net* energy) from a gallon of gasoline, and rising prices would be one obvious agent for technological change. With this in mind, the Resources for the Future model projects a reduction in the gross energy: GNP ratio from 68 Btu/dollar in 1975 to 47 by the year 2000; the Institute for Energy Analysis offers 42 for its low case and 50 for its high case, while DRI-Brookhaven suggests 44. (See Table II.)

Table I shows "gross" and "net" energy figures, a distinction which is now standard but somewhat misleading. Electricity, it is commonly asserted, is a wasteful energy source because only a third of the energy contained in the original fuel is turned into electricity. The net/gross distinction is based on this supposed waste. Gross energy is all the energy used either directly by consumers or in electric generating plants. It corresponds to the Btu requirements for supply. Net energy is the energy that goes to consumers plus the energy that comes out of electric generating plants. Hence, the net/gross ratio depends on the proportion of electricity being used in the projection.[48]

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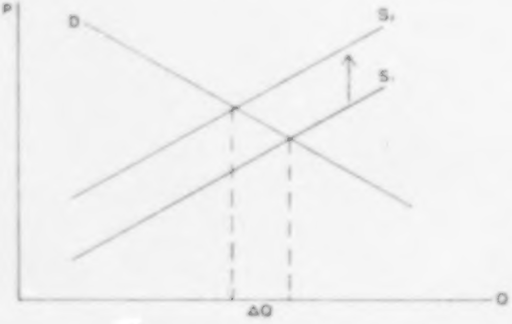
[67] W. B. Shew, internal memorandum, July 31, 1975, p. 6.

This distinction points up the supposed inefficiency of electricity while ignoring the very substantial end-use inefficiencies of other types of fuel use. The assumed 3:1 disadvantage of electricity is misleading because it does not take into account the inefficiencies at all stages in the sequence of producing, transporting and using fuels directly. (Measured efficiency of home furnaces is close to 50 percent, although theoretically a clean efficient furnace could work at nearer 80 percent.) A more useful definition of net fuel use might be the units of work (heat, miles, motor power) required or supplied for end-use. That sort of measure, while not currently available, would have two types of use: first, it would enable us to examine energy: GNP linkages in a more useful hypothesis, namely, is the end-use quantity of work related to GNP. Second, it would clarify some of the confusion surrounding the concept of conservation.

D. Conservation

Conservation, in the broadest sense, means "using less." But it actually encompasses several different phenomena which we can review in terms of the traditional supply and demand curves.

(1) Upward shift (price increase) in supply function.
No change in taste or technology.



The obvious example of this is the oil price increase. People use less at higher prices: either they drive fewer miles or have colder homes or, in the long run, they switch to fuel-saving technologies (smaller cars, insulation).

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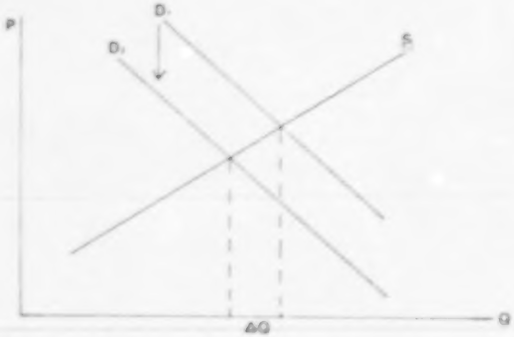
[48] For instance, the Department of Interior projections for gross and net energy for 1985 are 103.5 and 77.5 quads, respectively. Gross—Net=26 quads [this is the "waste" in electric generation]. Total electric included in the gross can then be estimated by assuming 33 percent efficiency: 26×312=39 quads. Thirty-nine quads as a percentage of total gross demand equals 39/103.2×100=38 percent, as shown in Table III.

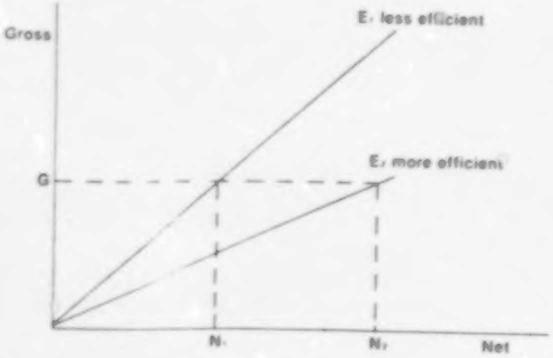
(2) Downward shift in demand function. No change in supply schedule or technology.



These are demand changes which may be caused by the availability of substitute commodities or which may reflect changes in taste and lifestyle rather than economics. Many of the social physicians hope to see bicycles replace automobiles because of their lifestyle implications. Exhortations that 65° is healthier than 72° for an indoor temperature are also attempts to shift the demand curve.

(3) Shifts in end-use conversion efficiencies through technical change

To review this, we have to specify our axes more clearly: supply and demand for what? With fixed technical efficiency options, the question does not arise. But suppose that a simple and costless invention[49] increased the end-use efficiency. What would be the effect? We must assume that demand for energy is not demand for gross Btus but for units of work (heat, miles, motor power), and that gross energy demand is a derived demand. Then a change in technical possibilities would shift a gross/net schedule in the following way:



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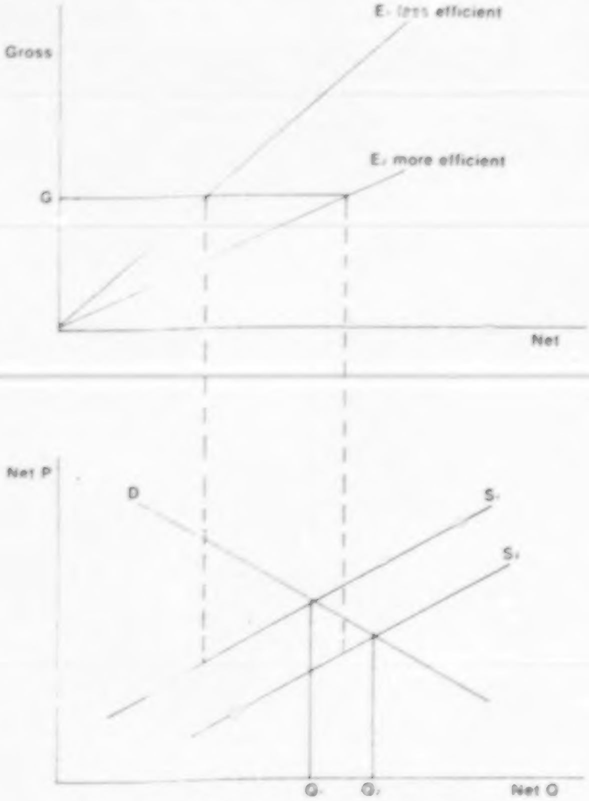
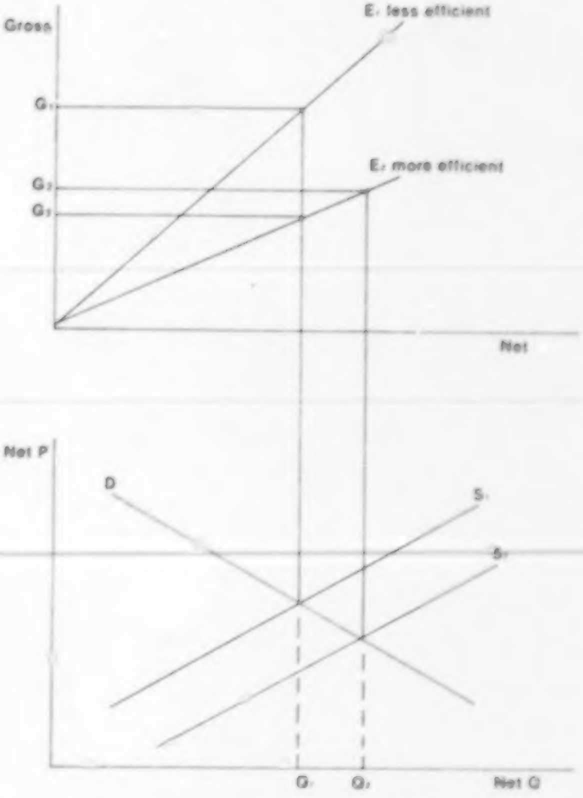
[49] Assuming the invention has a cost does not change the thrust of the argument.

(E_2 yields more units of net energy per unit of gross energy.) Assuming that demand is for net energy, this has the effect of shifting the supply curve of net energy downward, while leaving the demand schedule unmoved. The same amount of gross energy at the same price (on our assumption of a costless invention) can now provide more net energy at the same price.



If there is any elasticity of demand, △Q net will be positive, although so long as the elasticity of demand is not greater than unity, changes in *gross* energy consumption will be negative. In more mundane terms, more miles per gallon may induce people to drive more because it is cheaper per mile than before: in any event, this effect will limit the impact of technical efficiency in reducing gross Btu consumption.

Expanding the above diagram, we can see that one might have hoped the efficiency change would reduce gross consumption from G_1 to G_3. It will, however, only reduce it to G_2.



This is an extremely important result. Lovins' assertion that a 95-quad scenario for 2000 is feasible depends crucially on his assumption that conservation through technical efficiency changes alone can reduce gross energy demand. He asserts:

> Theoretical analysis suggests that in the long term, technical fixes *alone* in the United States could probably improve energy efficiency by a factor of at least three or four. A recent review of specific practical measures cogently argues that with only those technical fixes that could be implemented by about the turn of the century, we could nearly double the efficiency with which we use energy.[20]

Among the technical fixes he proposes are thermal insulation, heat pumps, more efficient furnaces and car engines, less overlighting and overventilation in commercial buildings and recuperators for waste heat in industrial processes. While all of these measures could "conserve" in the broad sense of "using less energy," all the fixes he suggests, with the possible exception of overlighting, have the effect of reducing the marginal cost of net energy or work units. They shift the supply curve downward. Lovins says:

> My own view of the evidence is, first, that we are adaptable enough to use technical fixes *alone* to double, in the next few decades, the amount of social benefit

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[20] Lovins, "Energy Strategy," p. 72.

> we wring from each unit of end-use energy; and second, that value changes which could either replace or supplement those technical changes are also occurring rapidly. If either of these views is right, or if both are partly right, we should be able to double end-use efficiency by the turn of the century or shortly thereafter, with minor or no changes in lifestyles or values save increasing comfort for modestly increasing numbers.[31]

In other words, the reduction from 155 quads to 95 quads is to be accomplished by increasing, in fact doubling, end-use efficiencies; what Lovins has not realized is that if there is any demand elasticity at all he will not be able to keep all the efficiency gain: the reduction in the marginal cost of work units or net energy will increase the net energy consumed and cut into his gross savings.

A doubling of end-use efficiency is equivalent to halving the price. This is not a small point. If the elasticity of demand of end-use energy is, say, −0.5, *net* demand will *increase* by a little more than 40 percent; gross demand will therefore not be halved, but will be reduced to 70 percent of the previous level, or 40 percent above Lovins' projection. What this means for Lovins' implied scenario is that a relatively costless technical fix, such as more efficient furnaces and automobile engines, or the heat pump, or even ASHRAE standards on new homes, will not save nearly as much energy as he hopes. Comparing his 95-quad scenario with the 155-quad projections he imputes to others, and assuming that costless technical fixes applied to 120 of the 155 quads account for the 60-quad difference, we can estimate that, on his assumption of doubling efficiency and our assumption of −0.5 demand elasticity, the 120 will go to 84 (70 percent of 120), not 60 (50 percent of 120), and the total demand would be 119 not 95 quads. (If technical fixes are not costless, the shift in the supply curve will be smaller, the net increase in demand will be smaller, and the gross savings greater from any given technical improvement.)

A revision of the 95-quad scenario to 119 would bring it much more in line with recent estimates for the year 2000, although still comfortably below the older "official estimates." Nevertheless, the growth implied over the next twenty-five years by a 95-quad scenario is only 20 quads, whereas a more realistic estimate would suggest planning for growth of at least 40 quads.

To be fair, Lovins does not ignore the other two types of conservation discussed above: he favors lifestyle changes (demand curve downward shifts) for philosophical reasons and he favors marginal cost pricing (supply curve upward shifts), a position with which we cannot possibly quarrel. Therefore, it is possible that not all of his 60-quad savings come from shifts of technology, but rather from a mixture of all three phenomena. However, if we make the crude assumption that energy is underpriced 20 percent, an increase to marginal cost, with a −0.5 elasticity would result in an end-use reduction of 9 percent, bringing us from 155 to 141 quads, and leaving 46 quads to be dealt with by technology shifts before we got to the 95-quad scenario.

The numbers outlined above are only indicative of possible problems: Lovins' thesis is, however, that technical fixes can reduce demand and soft technologies supply the reduced requirement. The latter assertion is examined in Section III, but as we have seen, the reduced demand scenario is probably substantially overdrawn.

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[31] Lovins, "Energy Strategy," p. 75.

III. THE "HARD" AND "SOFT" ENERGY SUPPLY PATHS

The basic assumptions underlying Lovins' discussion of the "hard" and "soft" energy supply paths are that (1) the two paths are mutually exclusive, (2) both paths represent difficult but very different problems, and (3) many genuine soft technologies are now available and are now economic.

A number of Lovins' critics have been puzzled as to why the two paths are "mutually exclusive." Lovins offers no explanation in his original *Foreign Affairs* article or even in the rebuttals that he has written to his critics' comments. The only rationale advanced for the mutually exclusive argument is that "commitments to the first *may* foreclose the second, [and] we must soon choose one or the other . . . ." [emphasis added].[52] Not only is this statement conditional, but there are no reasons given for why the assertion should be accepted as fact. On the contrary, many transitions in the sources from which energy is harnessed have taken place in the past in an orderly and compatible way. Between the 1850s and the late 1970s transitions that were not mutually exclusive have occurred as society moved in a series of steps from wood to coal, to oil, to gas and most recently to the use of nuclear energy.

While one might characterize all of these changes as merely being a replacement of one "hard" energy path by another, this is more a matter of semantics than of substance. In the 1850s the decreasing use of wood would have been viewed, using the Lovins terminology, as a replacement of a soft energy form (biomass) with a hard one (coal). However, the majority of these changes among fuel forms took place side-by-side with the availability of other proven soft technologies—windpower, hydropower and even solar energy—each of which could have become the dominant fuel source. Why they did not, if they were more economic or better in some other way, remains a mystery.

Other critics of Lovins have reviewed the analysis of the "hard" and "soft" supply paths and have frequently arrived at different interpretations of the state of the various technologies and their costs. It requires a wide background in the state of the art of various soft technologies which Lovins offers in place of the more conventional ones to evaluate how accurate his assertions are.

Claims that new technologies are both economic and ready to be applied widely on a commercial scale are common in the scientific and engineering community—even when there is little or no basis for such claims. It is only necessary to cite a few examples, chosen deliberately from the energy industries, to illustrate how carefully claims of the availability and economic competitiveness of a new technology must be evaluated. The evaluation must include not only an examination of the technical and economic status but, just as importantly, the nature of the environmental, political, institutional, legal, regulatory and financial barriers that must be overcome before the technology can be deployed widely enough to make an important contribution to energy supply. Making such evaluations has been just as difficult for new "hard" technologies as it has been for "soft" ones.

Even if the evaluation is favorable, there are very long lead times and large costs involved in commercialization. For example, the first fission chain reaction to prove the basic scientific principle needed to assure that atomic power could be produced from uranium was demonstrated in 1942. Despite the enormous commitments in funds and other resources that were made by the United States Government and others to convert this knowledge to practical use, the first small commercial reactor did not begin operation until 1959, nearly seventeen years later. In 1955, at which time small experimental reactors were already operational, the National Planning Association [53] predicted that by 1980, nearly forty years after the basic scientific principle had been proven, the United States would be supplying only 10 percent of its energy from nuclear fuels. In fact, in 1976 it supplied less than 3 percent of total energy demand and is projected to supply only 8 percent by 1985.

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[52] Lovins, "Energy Strategy," p. 65–66.

The slow commercial development of nuclear fuels is not just the result of the special problems associated with nuclear energy but typical of the difficulties in commercializing any new energy resource. The development of oil shale, coal liquefaction and coal gasification technologies have been even less successful than those for nuclear fuels. Oil from shale was produced in a number of countries in significant quantities in the 19th century but had largely disappeared by the turn of the century with the discovery of large oil reservoirs. For example, in 1860 a total of 53 U.S. companies were producing oil from coal and shale, but the discovery of liquid petroleum in 1859 soon ended the U.S. shale oil industry.[54] Interest in oil shale was revived in the 1920s due to the relatively high price of petroleum and several pilot plants were erected, including two by the Bureau of Mines. However, oil shale activity was again halted because large discoveries of petroleum caused a decrease in its price.[55] From time to time since then, notably after 1945, as oil reserves appeared to be becoming limited, studies were made that showed that oil from shale was competitive, or nearly competitive, with petroleum. Despite these repeated claims in reports made by both industry and government, no commercial oil shale plants are currently operating. Moreover, their future looks almost as bleak today as it did fifty years ago.

Coal gasification has had a history similar to that of oil shale. As with oil shale, claims have been made repeatedly by government research reports and by large industrial firms that coal could be gasified *at competitive prices* to make a high Btu gas that could be substituted for natural gas. In spite of the clear evidence that coal gasification is feasible, it has simply not been economic. Prior to 1940, low Btu coal gasifiers were used in the United States and during the 1940s and 1950s several attempts to develop new high Btu gasification processes were made. By 1973, at least twelve new processes were ready for commercialization, but costs were estimated to be three to four times the cost of natural gas.[56] Construction has not yet been started on the first commercial coal gasification plant and there is no indication that commercial plants will be constructed soon.

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[53] T. D. Teitelbaum, Productive Uses of Nuclear Energy—Report on Nuclear Energy and the U.S. Fuel Economy, 1955–1980, National Planning Association, Washington, D.C. (1958).

[54] A. Matzick, R. O. Dannenberg, J. R. Ruark, J. E. Phillips, J. D. Lankford and B. Guthrie, Development of the Bureau of Mines Gas-Combustion Oil-Shale Retorting Process, Bulletin 635, U.S. Bureau of Mines (1966), p. 2.

[55] Matzick et al., Gas-Combustion Oil-Shale Process, p. 2.

[56] U.S. National Academy of Engineering, Evaluation of Coal-Gasification Technology, Part I, Pipeline-Quality Gas, R&D Report No. 1, prepared for U.S. Office of Coal Research (1973).

Coal liquefaction to produce substitutes for crude petroleum and its products has had a similar history. In 1962, the National Coal Association announced that "[c]onversion of coal to fluid fuels is a technical reality,"[57] and in 1964 it reported that:

> Consolidation Coal Co. is designing a pilot plant to advance its technically proven process for producing economical, high-test gasoline from coal. Engineering and economic scrutiny indicates that a plant using 10,000 tons of coal per day could produce gasoline in competition with the petroleum industry.[58]

And four years later, it announced that "[g]asoline from coal . . . is off the bench, and the product is in the barrel. . . ."[59]

In all of these cases, the technology is clearly feasible and has been for some years, yet the economics have never enabled the technology to reach the commercial phase.

A. Fluidized-Bed Combustion

The most important transitional technology advocated by Lovins—fluidized-bed combustion of coal—has had an early history no different from those of the other technologies described above, and it is difficult to determine or understand why there exists optimism in some quarters regarding its future. R&D has been conducted on fluidized-bed combustion for about fifteen years. A few small plants using a modified fluidized-bed principle have been operating for a number of years but without the pollution control measures that would be required now on new plants. How the application of such measures would affect operability and costs is unknown.

Even the most aggressive proponents of fluidized-bed combustion believe that its initial application will be in relatively small plants—something that Lovins favors. But the use of coal in dispersed small installations introduces a whole host of complex factors that will affect both the utility and costs of fluidized-bed coal combustion. What type of industrial infrastructure will have to be developed to construct plants using this new technology? How rapidly could it be developed? What type of commercial infrastructure will have to be created to purchase and distribute coal in the small quantities that will be needed at many individual plants? How will the environmental problems associated with the storage and later distribution by the coal broker be solved? What methods will be used to dispose of the mixture of ash and spent limestone that will remain at these multitudes of small plants?

These and other problems associated with the use of coal in small plants (using fluidized-bed combustion or any other coal combustion technology) are soluble. However, the costs may be very high and thus reduce the potential use of coal in fluidized beds to a low level. Moreover, overcoming these problems can only reduce the rate of penetration of the new technology into the market.

One must therefore conclude that the status of fluidized-bed systems for burning coal in an environmentally acceptable way is still uncertain. A number of technical problems must be resolved before it is possible to "know" whether this type of process will work successfully with coal or even to estimate whether the costs will be competitive with alternative coal combustion processes that were once used extensively in small installations. Hopefully, the required information will be developed at an ERDA-sponsored experiment now being conducted in West Virginia on a 30-megawatt unit or in some other fluidized-bed combustion experiment. Until then, those who claim that the technology and the economics are proven must be viewed with the same caution one reserves for the proponents of oil shale, coal gasification and coal liquefaction.

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[57] National Coal Association, Bituminous Coal Facts 1962, p. 45.
[58] National Coal Association, Bituminous Coal Facts 1964, pp. 46–47.
[59] National Coal Association, Bituminous Coal Facts 1968, p. 21.

Finally, with respect to coal technology in general, Lovins concludes "[n]eglected for so many years, coal technology is now experiencing a virtual revolution."[60] There has been no revolution in coal technology to date—supercritical gas extraction, flash hydrogenation and flash hydrolysis have been the subject of experiments for twenty to fifty years. The only revolution that has occurred is that very much larger funds are being spent on R&D—mainly by the government—than were ever spent before. Whether this will result in the development of any radically new technology that will enable coal to be used in large amounts remains to be seen—probably in fifteen to twenty-five years.

B. Solar Energy

The history of solar energy development is very similar to that of many other promising technologies. The use of solar energy for water heating and for space heating and cooling has also received a great deal of research attention for a number of years. In 1964 Farrington Daniels said:

> There is no gamble in solar energy use; it is sure to work. It has been demonstrated that solar energy will heat, cool, convert salt water into fresh water, and generate power and electricity. The problem is to do these things cheaply enough to compete with the present methods based on fuel, electricity, animal power or manpower in any given locality.[61]

He was able to be this certain of the technical feasibility because the sun had been used successfully but intermittently and always on a small scale for nearly a hundred years for these very purposes. Important research on home heating was conducted in the 1930s and 1940s at MIT. Sporadic research continued until the early 1970s when a massive infusion of federal funds increased the size of the R&D effort by orders of magnitude.

Solar energy and other renewable resources may now be able to compete with the nonrenewable resources in many applications where their use was uneconomic over the past fifty years, since the prices for nonrenewable resources have increased sharply over the past four years—by as much as a factor of four—while those for most renewable resources have increased more modestly, if at all. It is, however, quite misleading of Lovins to assert on the basis of current cost comparisons that:

> In the United States (with fairly high average sunlight levels), they [solar heating, and, imminently, cooling] are cheaper than present electric heating virtually anywhere, cheaper than oil heat in many parts, and cheaper than gas and coal in some.[62]

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[60] Lovins, "Energy Strategy," p. 84.

[61] F. Daniels, The Direct Use of the Sun's Energy (New Haven: Yale University Press, 1964), p. 5.

[62] Lovins, "Energy Strategy," p. 81.

The *current* cost of solar panels is virtually irrelevant to the discussion. The question is not what one or two panels would cost, but what one or two million panels would cost. Solar collectors use aluminum and plate glass. Aluminum is probably the most highly energy-intensive industry in existence, and is currently located almost exclusively in the Northwest where electricity prices average 4 mills per kilowatt-hour. The marginal cost of new electricity to serve an expanded aluminum industry is nearer 2 cents. Plate glass prices include a substantial component for natural gas, where, again, the marginal cost is clearly above the current contract average. The costs of expanded supply of the soft technologies cannot be estimated simply by assuming that mass production will make them cheaper—it may make them much more expensive. Estimates of the speed with which any new energy technology can be introduced and its eventual share of the market, depend, or should depend, on calculations like these. We doubt whether anyone has done very sophisticated calculations in this area, but it seems quite possible that increased production of solar collectors would tend to drive the price *up*, not down.

Additionally, *capital* cost comparisons of alternative sources which Lovins uses freely, make no sense as a matter of economics. A $20 investment which lasts for five years is not necessarily cheaper than a $40 investment that last for fifteen years: the capital costs alone are only part of the equation. The relevant number for comparison purposes would include the expected life of the investment and the running costs (labor, fuel, materials) expected over that life. Lovins may be right in asserting solar is cheaper, but his methodology is not the right support for the assertion.

Lovins is particularly optimistic about the status of solar technology.

> Ingenious ways of backfitting existing urban and rural buildings (even large commercial ones) or their neighborhoods with efficient and exceedingly reliable solar collectors are being rapidly developed in both the private and public sectors. . . . Good solar hardware, often modular, is going into pilot or full-scale production over the next few years. . . .[63]

The actual state of development is not this favorable. There are over 120 companies manufacturing or in the advanced stage of developing solar collectors, but it is still not certain which general methods will be most successful.[64] Other manufacturers are in the process of developing new or modifying old designs of some of the needed ancillary components, but whether these components will be compatible with the collectors is yet to be determined.

In a new industry it might appear that having many companies starting to manufacture equipment would be an advantage in getting the technology deployed quickly. On the other hand, with no standards for manufacturers to meet, it is very likely that many solar energy systems that are marketed will be substandard. Even if they were not, the existence of a hundred different types of units, designed without minimum industry specifications, can only result in many custom-type installations that will make maintenance difficult to obtain and costly.

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[63] Lovins, "Energy Strategy," pp. 81–82.

[64] U.S. Energy Research and Development Administration, Catalog on Solar Energy Heating and Cooling Products (Washington, D.C.: U.S. Government Printing Office, October 1975).

If these problems actually do occur in early installations, it could have a strong negative effect on development of a solar industry.

Collectors can now be purchased commercially almost anywhere in the United States, but the number of operating systems is still small—about a thousand buildings throughout the country.[65] Until some long-term experience is gained with these early installations, actual lifecycle costs will remain speculative. The difficulty in retrofitting many existing installations is very great and most experts are not optimistic about developing economic ways to use solar energy for space heating and cooling in already constructed buildings.[66] If this view is correct, the rate of market penetration of solar energy for these uses can only be relatively slow. More success can be expected in retrofitting hot water heaters to use solar energy, but the total amount of energy used for this purpose is small.

Under the impetus of higher prices for conventional energy systems, incentives for using solar energy, large R. & D. expenditures to improve solar energy systems and massive sums spent on demonstration projects to establish the best methods for commercializing solar energy, wider and more rapid use of solar energy can be expected. However, there is at this time no technical justification for the great optimism expressed by Lovins concerning the technical feasibility, economics and the projected high rate of market penetration of solar energy systems.

C. Biomass

Because it will be necessary to have liquid fuels for transport in the Lovins scenario of the future, a soft technology is needed to produce these liquids. Conversion of biomass to methanol by enzymatic routes was proposed. According to Lovins "exciting developments in the conversion of agricultural, forestry and urban wastes to methanol and other liquid and gaseous fuels *now offer practical, economically* interesting technologies to run an efficient U.S. transport sector" [emphasis added].[67]

Alcohols and other potential nonpetroleum types of fuels were produced commercially from wood and other biomass feedstocks for many years. These operations ceased quickly, however, when catalytic methods were developed for producing these chemicals using coal, oil or gas as the raw material feedstock. In 1944, as part of the Synthetic Liquids Fuels Act, Congress appropriated funds to determine the manufacturing steps and costs of a small industrial plant scale of a process developed by the Bureau of Agricultural and Industrial Chemistry for the production of alcohol and other liquid fuels from agricultural residues.[68]

After several years of experimentation, the R&D was halted because it had become obvious that other ways of making synthetic fuels would be much more economic than processes based on agricultural residues.

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[65] "Solar Energy: An Industry in Search of a Market" Energy-BCC, Vol. 1, No. 4 (Summer-Fall 1976), p. 12. Abstract appearing in Energy Information Abstracts, Vol. 2, No. 1 (January-February 1977), p. 37.

[66] Economics of Solar Home Heating. Report prepared for the Joint Economic Committee, Congress of the United States (March 13, 1977), p. 8.

[67] Lovins, "Energy Strategy," p. 82.

[68] Public Law 290, Act of April 5, 1944 (58 Stat. 190, 30 U.S.C. Sections 321–325).

It is a gross exaggeration to imply that technologies exist or are even on the horizon for the *economic* production of alcohols or any other fuels from agricultural or forestry wastes. There is no doubt that alcohols can be produced by either enzymatic or more conventional processing of such wastes, but the costs are currently so much greater than alternative routes using other feedstocks that massive technical breakthroughs would be needed that have not yet been seriously studied even in a preliminary way.[69] Moreover, the overall environmental impacts on the land and the soil are unknown as are the types of adverse environmental impacts that the conversion plants would create. Even in the unlikely case that the costs appear attractive, there is not sufficient information to compare the relative environmental impacts of using conventional technology for producing alcohols from conventional fuels with the yet-to-be-studied, let alone commercially developed, systems suggested by Lovins.

In addition, it is doubtful that in practice the amount of biomass could be made available to produce the liquid fuels needed to operate the transport sector. As far as biomass potential from residues and municipal wastes is concerned, the Stanford Research Institute has concluded:

> About 1 quad of forest and agricultural residues and municipal waste are now used to produce energy and up to 10 quads are available. However, collection costs are too high for most of this resource to be used to produce energy unless competing fuels rise in price or raw biomass resource costs fall 50 percent below current forecasts.[70]

The potential for biomass based on plantation growing is even less likely to be cost competitive than that from currently produced biomass.[71] Even if it were attractive economically, it is very doubtful that there would be enough suitable extensive land areas not already being used for agricultural purposes to develop large biomass plantation. Using a number of smaller plots would increase the cost of delivering the biomass to a central plant. If many small plants were used to reduce transport costs then, except under unusual circumstances, costs of production would be higher.

D. Conclusion

There is no evidence that the hard and soft energy paths are mutually exclusive—a basic premise of the Lovins argument. Enough evidence does exist to conclude that hard and soft technologies can exist side by side, both being used to the extent that they provide the lowest-cost (including all external costs) source of energy. Until now, however, the soft supply technologies have been unable in most instances to compete with the hard ones. In fact, a transition from mostly soft technologies—biomass (wood), windpower, solar energy to a more limited extent and hydroelectric—took place worldwide in the past hundred years. This occurred not because the two types of energy supplies are mutually exclusive—in fact, they continue to coexist almost everywhere—but because under the existing conditions and under the constraints in operation, at least up until now, the hard technologies were generally less costly.

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[69] U.S. Energy Research and Development Administration, Division of Solar Energy, Solar Energy in America's Future A Preliminary Assessment (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 23–25.

[70] ERDA, Solar Energy, p. x.

[71] ERDA, Solar Energy, p. 24. See also A. D. Poole, "Flower Power, Prospects for Photosynthetic Energy," Bulletin of the Atomic Scientists (May 1976), p. 54; and Nuclear Power Issues and Choices, pp 136–137.

Major transitions have also occurred among the hard technology energy forms as the world moved from wood to coal, to oil, to gas and then to nuclear energy. These transitions were orderly; the use of wood did not disappear suddenly and, despite the massive inroads of oil and gas as a source of energy in the United States, coal production still remains at the level of thirty years ago. All the evidence, in fact, supports the view that there is no mutual exclusiveness to the use of many diverse supply forms, both hard and soft.

But let us assume for the moment that we must make a choice as to which of the two supply paths to select. How certain are we that the soft technologies can be successfully developed for widespread commercial use? Based on past experience with the development of new energy technologies, or even with new technologies in most other areas, one can only conclude that we are in no position to place great reliance on these still-to-be-demonstrated energy technologies. The fact that they are soft and as Lovins says "flexible, resilient, sustainable and benign" is no assurance that they will be any easier to commercialize than hard technologies. We must be as conservative in appraising the new soft technologies as experience has taught us to be for new hard technologies.

The more information one could develop about the competing systems before selecting one, the more confident society could be that it had selected the "better" path. At the moment, the data base on which to make a decision is weak. Since there is no urgency in making a selection, it would be wise to delay a commitment to a single course (should that ultimately appear necessary for some reason) and to develop more reliable technical and other information on which to make the choice.

The prudent course seems clear. Since there is no reason why two paths should not both be used at the same time—each where it is most suitable—a policy should be adopted of developing and using as much of the renewable resources as can be justified. If commercial experience with technologies in their current state and if R. & D. on these resources result in improved technology, the soft path will become increasingly important as a source of energy supply. Under these circumstances, hard technologies will be phased out gradually and in an orderly fashion. If, on the other hand, those soft technologies that are now being advocated are not successful, no unnecessary risks will have been taken in providing an adequate energy supply that is so necessary for economic well-being. The hard technologies will then still be available in some form to provide the energy needed.

TABLE I.—COMPARISON OF ENERGY CONSUMPTION PROJECTIONS FOR THE UNITED STATES

[Total energy consumption in quads]

Study/case	1975 (1)	1980 (2)	1985 (3)	2000 (4)	2010 (5)	2025 (6)
(1) RFF base case:						
Gross	74.9	86.6	93.0	114.2	138.9	171.4
Net	60.2	68.2	70.5	85.2	105.5	128.4
(2) DRI-Brookhaven:						
Base case—Gross			100.0	156.2		
Energy tax case—Gross			93.5	117.9		
(3) Energy policy project:						
Historical growth case—Gross			116.1	186.7		
Technical fix case—Gross			91.3	124.0		
(4) FEA National Energy Outlook: $13 oil case—Gross			98.9			
(5) Department of the Interior:						
Gross		87.1	103.5	163.4		
Net		68.9	77.5	110.2		
(6) Institute for Energy Analysis:						
Low case—Gross			82.1	101.4	118.3	
High case—Gross			88.0	125.9	158.8	
(7) ERDA-48—Gross:						
Historical base case			107.3	165.5		
Improved end—Use efficiency case			97.0	122.5		
Coal and shale synthetics case			107.3	165.4		
Intensive electrification case			106.8	161.2		
Limited nuclear case			107.0	158.0		
Combination case			98.1	137.0		

SOURCES

(1) Resources for the Future, draft report to be submitted to the National Institutes of Health, March 1977.

(2) Data Resources, Inc. and Brrookhaven National Laboratory, "The Relationship of Energy Growth to Economic Growth Under Alternative Energy Policies," prepared for U.S. ERDA, March 1976.

(3) Energy Policy Project of the Ford Foundation, "A Time to Choose: America's Energy Future," (Cambridge, Mass.: Ballinger, 1974)

(4) Federal Energy Administration, "National Energy Outlook," (Washington, D.C., U.S. Government Printing Office, February 1976).

(5) Walter G. Dupree, Jr., and John J. Corsentino, "U.S. Energy Through the Year 2000 (revised)," U.S. Department of the Interior (December 1975).

(6) Institute for Energy Analysis, "Economic and Environmental Implications of a U.S. Nuclear Moratorium, 1985-2010" (Oak Ridge, Tenn.: September 1976).

(7) Energy Research and Development Administration, "A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future," vol. I, June 28, 1975.

TABLE II.—COMPARISON OF ENERGY CONSUMPTION PROJECTIONS FOR THE UNITED STATES

[Energy: GNP ratio—(10^3 Btu/$71)]

Study/case	1975 (1)	1980 (2)	1985 (3)	2000 (4)	2010 (5)	2025 (6)
(1) RFF base case:						
Gross	68	62	59	47	44	40
Net	55	49	45	36	34	31
(2) DRI-Brookhaven:						
Base case—Gross			50	44		
Energy tax case—Gross			49	39		
(3) Energy policy project:						
Historical growth case—Gross			56	55		
Technical fix case—Gross			47	36		
(4) FEA National Energy Outlook: $13 oil case—Gross			57			
(5) Department of the Interior:						
Gross		56	57	55		
Net		45	42	37		
(6) Institute for Energy Analysis:						
Low case—Gross			51	42	38	
High case—Gross			54	50	47	

SOURCES

(1) Resources for the Future, draft report to be submitted to the National Institutes of Health, March 1977.

(2) Data Resources, Inc. and Brookhaven National Laboratory, "The Relationship of Energy Growth to Economic Growth Under Alternative Energy Policies," prepared for U.S. ERDA, March 1976.

(3) Energy Policy Project of the Ford Foundation, "A Time to Choose: America's Energy Future, (Cambridge, Mass.: Ballinger, 1974).

(4) Federal Energy Administration, "National Energy Outlook," (Washington, D.C., U.S. Government Printing Office, February 1976).

(5) Walter G. Dupree, Jr., and John J. Corsentino, "U.S. Energy through the Year 2000 (revised), "U.S. Department of the Interior (December 1975).

(6) Institute for Energy Analysis, "Economic and Environmental Implications of a U.S. Nuclear Moratorium, 1985–2010" (Oak Ridge, Tenn.: September 1976).

TABLE III.—COMPARISON OF ENERGY CONSUMPTION PROJECTIONS FOR THE UNITED STATES

[Percentage of energy consumed as electricity]

Study/Case	1985 (1)	2000 (2)	2025 (3)
(1) RFF base case	38.5	43.0	43.7
(2) FEA Project Independence:			
Business as usual case ($7 oil, no conservation)	37.5		
Accelerated case ($11 oil with conservation)	37.0		
(3) FEA National Energy Outlook: Reference case	34.1		
(4) Energy policy project:			
Historical growth case	32.3	39.1	
Technical fix case	25.4	24.8	
Zero growth case	26.0	31.1	
(5) Department of the Interior:			
December 1972 case	34.6	41.9	
December 1975 (revised) case	37.8	48.1	
(6) National Petroleum Council: Intermediate case	35.5		

SOURCES

(1) Resources for the Future, draft report to be submitted to the National Institutes of Health, March 1977.

(2) Federal Energy Administration, "Project Independence Report," (Washington, D.C.: U.S. Government Printing Office, November 1974).

(3) Federal Energy Administration, "National Energy Outlook" (Washington, D.C.: U.S. Government Printing Office, February 1976).

(4) Energy Policy Project of the Ford Foundation, "A Time To Choose: America's Energy Future," (Cambridge, Mass.: Ballinger, 1974).

(5) Walter G. Dupree, Jr., and John S. Corsentino, "U.S. Energy Through the Year 2000 (revised)," U.S. Department of the Interior (December 1975).

(6) National Petroleum Council, "U.S. Energy Outlook, A Summary Report of the National Petroleum Council," U.S. Department of the Interior (December 1972).

D. The Potential for Industrial Energy Conservation

INDUSTRY CAN SAVE ENERGY WITHOUT STUNTING ITS GROWTH

(By Tom Alexander)*

To the dismay of many businessmen, President Carter's energy program breaks with the policies of previous Administrations by stressing conservation more than the development of new supplies. Ever since the energy crisis hit, the instinctive response of the U.S. has been like that of an animal deprived of its food: a nervous questing after new sources. Behind this drive was the assumption that the economic organism would suffer malnutrition and stunted growth were it not fed the large and growing energy diet to which it was accustomed. A national policy of reducing the rate of growth of consumption, in other words, has been widely equated with the sort of deprivation that is welcomed only by a few middle-class extollers of the simpler life.

But mounting evidence—from other countries, from recent U.S. experience, and even from theoretical physics—suggests that prosperity and growth are not so rigidly coupled to an increasing energy diet as was long supposed. A number of economists and engineers, in and out of government, have been grappling with the question of how the U.S. can curb its gluttonous, and probably unsustainable, energy appetite. Some have been surprised by their own conclusion that the nation, after experiencing an unavoidable bulge in consumption during the next decade or so, could wind up around the year 2000 using no more energy than it does now. In the meantime, it could continue achieving respectable economic growth, though perhaps not at the exuberant rates of the cheap-energy years.

The portrait these experts paint of an energy-efficient society looks to be a far cry from the nontechnological, Thoreauvian rusticity that the word "conservation" evokes in many people's minds. Instead, it would be a tightly organized, capital-intensive society whose hallmark would be meticulous engineering. In the interim, a lot of resources would have to be redirected. Building an energy-efficient society would mean altering or retiring a considerable portion of the capital and consumer goods that were designed for an era when energy was cheap and plentiful.

A $500-BILLION CAPITAL-GOODS BOOM

But change, of course, is what industry is all about. Contrary to businessmen's fears of wrenching decline, constructing that society and its accoutrements represents a seldom-matched opportunity to devise and market a vast array of brand-new goods. This opportunity comes at a time when slowing population growth and saturating consumer markets are making a lot of business lives either boringly routine or brusingly overcompetitive. Roger W. Sant, a former head of conservation for the Federal Energy Administration and now a private consultant to government and business, estimates that energy conservation could generate up to $500 billion in capital outlays between now and 1985. And if that sounds prohibitively costly, it is useful to keep in mind that *without* conservation, the nation faces a far higher bill for the additional energy it will need.

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*From Fortune, May 1977, p. 186–200. Reprinted by permission.

LOWERING THE PROJECTIONS

Until fairly recently, most estimates of how much energy the U.S. would require in the future were prepared by the petroleum industry, government officials, and others whose experience and concern were mostly with supply, not conservation. Generally speaking, their projections were extrapolations from growth patterns of the past when energy was cheap and getting cheaper in real terms. Nor did they see much elasticity of demand with rising prices. Accordingly, typical forecasts from the early Seventies saw consumption growing from the 1973 level of 75 "quads" (quadrillions of British thermal units) to between 115 and 125 quads in 1985 and continuing on up to around 200 quads by the year 2000.

The Ford Foundation Energy Policy Project's 1974 report, "A Time to Choose," was the first major study to stress conservation. It drew a lot of flak by asserting that the nation could travel the path of zero energy growth, after reaching the 100-quad level in 1985, with essentially no damage to economic welfare. Critics in industry, government, and the universities found the report unrealistic in its assumptions about how rapidly society could or should change. Last September, though, the Institute for Energy Analysis of Oak Ridge Associated Universities—an organization that includes several individuals, such as nuclear physicist Alvin M. Weinberg, who have traditionally been associated with the "supply" camp—came out with an influential study outlining-surprisingly low projections of energy needs.

Using new data and plausible assumptions about trends in energy prices, population growth, productivity, and in the market saturation of automobiles and household appliances, the institute put U.S. energy demand at between 101 and 126 quads by the year 2000—little more than half the figure that seemed likely in most earlier studies. Moreover, the Oak Ridge study concluded, real G.N.P. per capita could easily grow at between 2.4 and 2.6 percent a year, not as fast as in the soaring Sixties and early Seventies but faster than the long-term average rate that has prevailed since 1940.

Researchers working on a still-unfinished study for the National Academy of Sciences see the possibility that consumption at the end of the century might conceivably be even lower—possibly in the 70-quad range. That conclusion has been echoed by researchers working for the Department of Commerce, whose analysis stress that energy consumption will have to continue climbing from now until the late Eighties before it can turn downward again, partly because of the slow pace at which energy-using machines wear out and get replaced.

A major difference between many of the old, high-demand forecasts and the newer ones is that the former took it for granted that most energy conservation would occur in the household, transportation, and commercial sectors. It would consist of measures like insulating homes, turning down thermostats, and driving more efficient automobiles at 55 mph. All these savings would be more than offset by increased consumption in the industrial sector, where it was assumed that most businesses were already operating pretty efficiently and where energy usage would grow in step with output.

So far, what has happened is the exact reverse. Of all the energy-consuming sectors, industry is the only one that consumed less energy in 1976 than it did in 1973. Overall, it consumed 6.2 percent fewer BTU's in producing almost exactly the same volume of goods. Meanwhile, the BTU's consumed by the residential-commercial and transportation sectors increased by 3.4 and 2 percent respectively.

THE BIGGEST GAINS LIE IN REDESIGN

Most of the industrial savings to date, to be sure, have been in the nature of pretty unexciting "housekeeping" measures. They include things like turning off lights and machines that are not being used or repairing leaks in high-pressure steam lines or in the thousands of trouble-plagued "steam traps" that separate live steam from condensed water. Less obvious, more expensive approaches have included tricks like replacing oversized electric motors or even installing small power-generating turbines in place of the pressure let-down valves that reduce the 300-pounds-per-square-inch pressure in a natural-gas pipeline to the 30 psi that a furnace might require.

Obviously, only so many of these comparatively painless savings are possible in any existing plant, and industry has probably spotted many of them by now. Most of the remaining improvements will require far costlier alterations and replacements of existing equipment, and in many cases a complete redesign of industrial processes.

But the amount of energy that can be saved that way is absolutely immense. Most of the plants now in existence were built when energy cost a lot less in the United States than it did almost anywhere in the world—as it still does. Seeking an optimum balance between the costs of labor, capital, materials, energy, and so forth, U.S. designers have generally paid a lot less attention to energy efficiency than have their counterparts elsewhere. Now, energy costs weigh far more heavily and, despite the pretense of the politicians to hold back the tide with oil and gas price controls, they will probably weigh even more heavily in the years ahead.

Europe and Japan furnish clear evidence that the demand for energy is price-elastic. The average price of various fuels in these countries ranges from 1.2 to 2.5 times that in the U.S., while the countries' per capita consumption—in the transportation, residential, and commercial as well as industrial sectors—averages about 50 percent less. Some of the disparity, to be sure, can be put down to differences in per capita income, to cooler summers, more apartment living, shorter commutes and freight hauls, and so forth. But even foreign industries that perform approximately the same jobs as their U.S. counterparts manage to use a lot less energy.

THOSE ENERGY-STINGY FRENCH SMELTERS

In West Germany, for instance, five energy-intensive industry categories—food; chemicals; petroleum and coal products; stone, clay, glass, and concrete products; and primary metals—use around 35 percent less energy per dollar of sales than the same industries in the U.S. The effect of price on energy consumption shows up even in processes that are in most respects identical. Both the U.S. and France employ the electrolytic Hall process for refining aluminum. Since the French pay 70 percent more for their electricity, they operate their smelting pots with less current. The penalty is slightly lower production per man-hour and per dollar of invested capital, but the French expend about 22 percent less energy per ton of aluminum.

Since the OPEC price hike, the energy prices paid by consumers in every major industrialized country in the world have shot up a lot higher than prices paid by consumers in the U.S. The consequence is that U.S. industry is a laggard in reducing consumption. As energy prices climb, however, all kinds of new processes will become competitive. In the case of aluminum, for instance, Alcoa is now developing a chlorine process that purportedly requires around 30 percent less electricity than the best Hall smelters, though it may cost more to build. Dow Chemical Co. has opened a plant for making ethylene dichloride that requires 85 percent less energy per pound than older plants.

Once engineers start looking at most common industrial processes with an eye to cutting energy use, the opportunities generally seem boundless. Engine exhausts, kilns, furnaces, soaking pits, ovens, distillation towers, and so forth are merely a few of the thousands of industrial devices that have long been allowed to spew valuable heat into the atmosphere. In most cases, that heat can be retained or used for some other purpose.

As the opportunities unfold, a huge market should develop for all kinds of heat exchangers—boilers, recuperators, regenerators, etc.—the function of which is to extract heat from one stream of gas or liquid and transfer it to another. One potentially enormous source of heat, for example, is the hot water discharged by electric-power plants and some other industries. In nearly all the countries of both Eastern and Western Europe, much of this water is used for "district heating"—i.e., to heat nearby commercial buildings and apartment houses.

IT PAYS TO KEEP THINGS HOT AND DRY

Often, energy efficiency consists merely of not allowing something to cool off. The basic process streams of steel mills, for instance, consist of ore pellets, sinter, coke, and coke-oven gas going in, and pig iron, steel ingots, slabs, blooms, billets, and coils coming out. Normally each of these is heated more than once. Recent developments, such as continuous casting, reduce the heat required in the output stream, while some companies are investigating the advantages of not permitting newly made ore pellets and coke to cool before they are used.

Just as multiple heating and cooling wastes energy, so does multiple wetting and drying. Most of the energy in the pulp and paper industry, for instance, goes into drying things out. The pulp from a pulp mill is normally dried before it is shipped to a paper mill, where it is moistened again, converted into paper, and dried once more. Making pulp and paper at the same site can save more than 10 percent of the energy. Experiments are under way in Sweden to make paper without water. Many U.S. cement makers still grind cement as a wet slurry that must be dried, while in many other countries they make it dry to begin with.

The U.S. textile industry is experimenting with dyeing fabrics with colored foams instead of wet solutions, thereby reducing drying times.

Improvements in the efficiency of energy production are at least as important as improvements in the efficiency of energy use. A lot of the fuel in an industrial boiler just goes into heating up the air in the fuel-air mixture itself. An obvious first step is to adjust the air-fuel mixture fed into a furnace to optimum proportions. Better yet is to use waste heat from elsewhere to preheat the combusion air before it goes to the furnace. This also enables the furnace to operate on a "leaner" fuel-air mixture: that is, one with a fuel ratio that would be too low to support combustion with cold air.

This principle has recently been put to ingenious boot-strapping use in a coil-coating oven developed by the Canadian firm, BNK Industries, with some help from the U.S. Energy Research and Development Administration. These gas-fired ovens bake out the solvents used in cleaning and painting sheet metal. The Environmental Protection Agency has ordered that all such ovens be fitted with "after-burners" to burn the solvent fumes emitted by the ovens. When the gas crisis began shaping up, it occurred to BNK to modify the ovens so that the solvent fumes themselves become the fuel that fires the oven. With some funding help from ERDA and the National Coil Coaters Association, BNK modified an oven for one of its industrial customers in time for the gas crisis. It worked so well that BNK already has orders for several more modifications.

Over the long haul, the greatest promise for reducing industrial energy consumption lies in applying some long-known but astonishingly neglected insights that are implicit in the physicists' second law of thermodynamics. Most of the calculations of how much energy industry could save have been based exclusively on the *first* law of thermodynamics, the physical law that says that energy is neither created nor destroyed, but only transformed. Efficiency, in the eyes of that law, is the ratio between the useful work that a device performs and the amount of energy put into it.

What the second law addresses, however, is the *quality* of energy. That law holds, in effect, that thermal energy is a bit like water power: it can only power man's devices when it can flow from a region of high potential—high altitude in the case of water, high temperature in the case of thermal energy—to a region of lower potential. The implication, according to the second law, is that the actual usefulness of any given BTU of energy is not a constant but a variable quantity. As soon as a BTU of energy is released in the combustion process, it immediately begins to flow "downhill": that is, to dissipate itself into the cool surrounding environment where it becomes gradually lost to mankind's purposes.

A simple example illustrates the difference between the first and second laws: if you drop a red-hot block of iron into a kettle of water, it will turn some of the water to steam. In principle anyway, the steam could be sent through a turbine to generate a certain amount of electricity. Alternatively, though, the red-hot block could first be mixed with a lot of blocks that were initially at room temperature. Assuming that they have no other way of losing their heat, all the now-lukewarm blocks together would still contain the same number of BTU's of heat that were initially in the first block alone. But that heat wouldn't be able to do much work; if dropped into the same kettle of water, the blocks would produce no steam and no electricity at all.

THE ANALOGY OF A WASTED WATERFALL

Typically, most industrial processes waste huge amounts of the potential available work that the second law says is in every molecule of fuel. More than 45 percent of the energy used by American industry, for example, goes into making "process steam," which is used at a typical temperature of around 350° F. By first-law standards, the boilers in which that steam is made are pretty efficient devices; roughly 85 percent of the BTU's initially in the fossil fuel wind up in the steam.

But by second-law standards, these systems are scandalously inefficient, since they will exploit no more than than about 25 percent of the fuel's available work. The reason is that the fuel molecules themselves—whether oil, natural gas, or coal—burn at a temperature around 3,600° F. To immediately dilute that wonderful, high-quality heat to the level of 350° is lamentably wasteful. It is the equivalent of building a 250-foot-high dam at the bottom of a 1,000-foot waterfall, and using only the 250-foot "head" in the man-made lake to generate electricity, instead of constructing penstocks to harness the far more potent 1,000-foot plunge of water from the top of the waterfall.

The era of cheap fuels led to a blithe disregard of second-law fundamentals and to the waste of unbelievable quantities of energy. On contracts from the Ford Foundation and the Federal Energy Administration, Thermo Electron Corp.—a company on Route 128 near Boston that makes furnaces, turbines, and other energy-using equipment for industry—has studied the processing technologies of a number of energy-intensive U.S. industries. It concludes that industry as a whole achieves an overall second-law efficiency of around 13 percent. Thermo Electron calculates that if that efficiency were raised only one percentage point, it would save some 3 percent of the total energy now consumed in the U.S.

DOWN AN ENERGY STAIRCASE

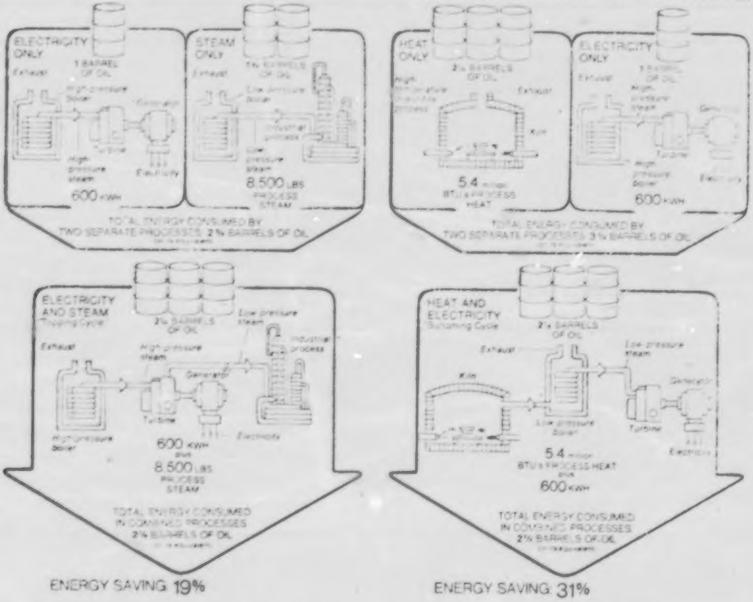
There are many ways to capture more of the available work that's in every pound of fuel. Mostly the techniques involve coupling together different devices that require different temperature levels, a strategy known as "cascading." In principle, the fuel could first be burned inside thermionic or magnetohydrodynamic generators that are under development—devices that require very high temperatures to operate at all. What they do, in effect, is convert into electricity some of the energy carried by the rapidly moving ions emerging from the combustion process itself. After leaving this first stage, the somewhat cooler gases could be ducted directly to some sort of furnace to melt steel. The exhaust from the furnace could then be sent to a boiler to create process steam.

As the final step in this fanciful scenario, the hot water emerging from the manufacturing plant could be used to heat nearby office buildings or houses. It might even be worthwhile from a second-law standpoint to raise the temperature of some of the water by means of an electrically driven heat pump and use it to create some more process steam. By such complicated tactics it would be possible to reach a second-law efficiency of perhaps 30 to 40 percent.

President Carter's new energy policy foresees widespread use of a simpler form of cascading called "co-generation." This linkup, which combines electricity generation with process heat or steam production, offers great promise of reducing national energy requirements, while at the same time reducing the awesomely burgeoning capital demands of the electrical utilities.

One study, coordinated by Dow Chemical Co. under National Science Foundation sponsorship, estimates that by 1985, industry could economically justify producing about a third of its electric-power needs and half its process steam through co-generation. That would save the country 680,000 barrels of oil per day, reduce the capital requirements of the nation's utilities by $4.1 billion per year between now and the mid-Eighties, and cut the average price of electricity paid by residential and industrial consumers by somewhere between 2.9 and 6 percent. Another study, by Thermo Electron, concludes that if the energy wasted in the paper, steel, and petrochemical industries alone were fully exploited through co-generation, it would supply a third of the total electrical requirements of the U.S.

HOW TO SAVE FUEL THROUGH CO-GENERATION


ELECTRICITY ONLY
1 BARREL OF OIL
Exhaust
High-pressure boiler
Generator
Turbine
High-pressure steam
Electricity
600 KWH
STEAM ONLY
1¼ BARRELS OF OIL
Exhaust
Low-pressure boiler
Industrial process
Low-pressure steam
8,500 LBS PROCESS STEAM
TOTAL ENERGY CONSUMED BY TWO SEPARATE PROCESSES: 2¼ BARRELS OF OIL
HEAT ONLY
2¼ BARRELS OF OIL
Exhaust
Kiln
5.4 million BTU's PROCESS HEAT
ELECTRICITY ONLY
1 BARREL OF OIL
Exhaust
Generator
Turbine
High-pressure boiler
Electricity
600 KWH
TOTAL ENERGY CONSUMED BY TWO SEPARATE PROCESSES: 3¼ BARRELS OF OIL
ELECTRICITY AND STEAM
Topping Cycle
2¼ BARRELS OF OIL
Exhaust
High-pressure steam
Low-pressure steam
Industrial process
Generator
Turbine
High-pressure boiler
Electricity
600 KWH plus 8,500 LBS PROCESS STEAM
TOTAL ENERGY CONSUMED IN COMBINED PROCESSES 2¼ BARRELS OF OIL
ENERGY SAVING: 19%
HEAT AND ELECTRICITY
Bottoming Cycle
2¼ BARRELS OF OIL
Exhaust
Kiln
Low-pressure steam
Generator
Low-pressure boiler
Turbine
Electricity
5.4 million BTU's PROCESS HEAT plus 600 KWH
TOTAL ENERGY CONSUMED IN COMBINED PROCESSES 2¼ BARRELS OF OIL
ENERGY SAVING: 31%

The hottest "new" idea in energy-policy circles is to revive the old technique of "co-generation" — producing electricity along with heat or steam that will be used for other purposes. Co-generation can take many forms. What all have in common is that they increase the amount of useful energy extracted from each pound of fuel. All forms, furthermore, employ either "topping cycle" or "bottoming cycle" generators, depending upon whether the electricity is produced before or after the process heat.

The left-hand diagram directly above illustrates one version of a topping cycle. An ordinary industrial boiler that converts 8,500 pounds of water every hour into steam at a temperature of 300° F. and 50 pounds per square inch of pressure is replaced by a boiler that produces higher-grade, 700°, 800-psi steam that is first sent through a "back-pressure turbine" to generate electricity. After it emerges from the turbine, it still has the 300°, 50-psi levels that an industrial process might require. Creating that initial high-grade steam, to be sure, takes extra energy. But the total fuel savings over separate power and steam production, according to Thermo Electron Corp., which supplied the data for these diagrams, amounts to 19 percent.

In the bottoming-cycle approach illustrated directly above at right, high-temperature gases from a furnace (kiln) are ducted to a boiler producing 450° steam at 400 psi. This generates power in a turbine. The fuel savings in this case are even more impressive — 31 percent less than would be consumed if the heat and electricity were produced separately. Along with saving energy, both the topping and bottoming cycles save capital and reduce pollution.

Co-generation is nothing new. Industry produces about 29 percent of the total electric power of West Germany, where much of its power is fed into the national grid. Co-generation also supplies around 10 percent of the electricity requirements of American companies, many of which also sold power at one time. Since the 1920's, though, a host of regulatory, institutional, and economic barriers in this country have discouraged co-generation. States have held that companies selling power to utilities must be regulated as utilities themselves. Most companies would rather die.

Utilities long ago became reluctant to buy the power, in part because it was often erratically produced and therefore a certain amount of backup equipment was required. Furthermore, until the late Sixties, electricity from the utilities kept getting cheaper and cheaper. And manufacturing plants found it more economical to replace their cranky coal-fired co-generation plants with low-cost prefabricated boilers that burned cheap oil or gas to make steam alone.

Another form of co-generation, also far more prevalent in Europe than in the U.S., involves a central electric plant that produces and sells steam or hot water to either industry or residential complexes. The general constraint is that everything has to be located close together because of the cost and energy losses associated with piping steam or hot water.

A BETTER WAY TO BURN COAL

This central-station approach to co-generation, lately expanded into a more ambitious "energy center" concept, is being championed in this country by Gerald L. Decker, corporate energy manager for Dow Chemical, among others. Energy centers, a few of which already exist, generally consist of a power plant plus one or more manufacturing plants sited closely enough together to share steam. More such arrangements would save energy and reduce the amount of waste heat that now winds up polluting lakes and rivers—heat that amounts to about two-thirds of the energy consumer in making electricity. They would also further a major aim of U.S. energy policy—[illegible] switch from oil and gas to coal.

As of now, most plant managers contemplate the prospect of burning coal with considerable unhappiness. A coal-fired boiler or furnace costs on average three to four times as much as its oil- or gas-fired counterpart. Coal is dirty and inherently polluting; storing it takes up a lot of valuable real estate, and hauling it around is a lot more cumbersome than pumping oil or gas. And while the future oil supply may be problematical, the infrastructure for supplying coal is exposed to a range of labor, environmental, and transportation uncertainties that are even scarier to most managers.

Many of the objections to coal are minimized in large central power or steam plants. Stokers, boilers, and stack-gas scrubbers are all proportionately cheaper in larger sizes. Utilities are accustomed to writing long-term supply contracts, and the mining and transportation industries can accommodate these well-anticipated demands.

THE ANOMALIES OF "AVERAGE" PRICING

Already, the pressures of energy scarcity are forcing some major new moves in the direction of energy centers. Many of the petrochemical plants that settled in the Gulf Coast region to take advantage of natural gas at 20 cents per million BTU's now find themselves faced with the prospect of paying ten times as much and more. Worse than that, it's virtually certain that the government will force them to switch to coal.

Meanwhile, Gulf States Utilities, a principal supplier of electricity to the region, is not only facing similar prospects but also a tremendous burden of paying for the switch over and for new additions to capacity. Recently, Gulf States and the petrochemical companies in several Gulf area locations have been trying to get together on a plan for jointly building large new coal-burning plants that would generate steam and power.

One advantage of such an undertaking is that the power and steam could be sold to users under very long-term contracts that would assure a supply at fixed prices plus some form of escalation. This increased certainty might well offset one of the economic handicaps of most co-generation projects under the present rules of the game. This is the fact that their electricity, in the short run at least, can be undercut in price by power from conventional energy-wasting utility generating plants, even when those plants are built at today's hugely inflated costs.

This is an example of the way politically influenced rate making takes precedence over economic rationality. In free-market commodity transactions, prices generally reflect the marginal costs of production. But state public-utility commissions generally base electrical rates on the average costs of owning and operating the utility equipment, which includes the cheaper old generating plants as well as the costly new ones. Moreover, the rate structures tend to favor industrial bulk users or power.

On top of that, the utility has a monopoly in its area and, being in effect a ward of the government, can get by with a lower rate of return on capital. When a manufacturing company—particularly one that is already highly leveraged—can get its hands on investment dollars, it often prefers to spend them on expanding plant or market share rather than on production economies, even when the rates of return favor the latter.

Late last year, a major cement company investigated buying a co-generating system to tap waste heat from some of its kilns and generate 4,700 kilowatts of power. The cost of the equipment would have been around $2.7 million and the "fuel," of course, would have been free. But partly because of the low "average" price that the company currently pays for purchased power, it decided against the project even though the purchased power is subject to unforeseeable rate increases. Even so, the rate of return on the co-generation project would have been a very attractive 22 percent. But this company, like many, had a double standard, insisting on a 30 percent return from cost-cutting projects while settling for only 15 percent on those that expand capacity.

What made sense to the cement company, however, makes no sense for the country. An equivalent amount of new generating capacity, including fuel-supply facilities, transmission lines, etc., will eventually have to be built, at a cost of more than $7 million to the electric utility that supplies the company's power. Thus the nation will waste at least $4 million of scarce capital, burn the equivalent of 180 barrels of unnecessary oil per day, and get some additional air pollution in the bargain.

RULES THAT CAN BACKFIRE

Often, government's instinctive response to such tales is to revert to the whip of law rather than to attack the market incongruities that were responsible in the first place. Among the proposals being considered in Washington, for example, is one that would require that every industrial steam boiler above such-and-such a size be equipped to co-generate electricity. Other proposals would require that every boiler, or every industrial process, meet such-and-such a standard of efficiency.

The Federal Energy Administration already has a so-called "mandatory" program for industry that calls for an average 18 percent efficiency improvement in the fifty largest companies in each of the ten most energy-hungry industries. So far, the only thing really mandatory about the FEA's program is that each company must report how well it is doing. No sanctions—except perhaps embarrassing publicity—are now in the law to enforce those standards.

But even this approach contains elements of inequity and the seeds of its own defeat. Mandatory requirements tend to penalize those companies that have been the most efficient in the past. They would also tend to discourage the changeover to coal, which usually burns less efficiently in boilers than oil or gas. One astute analyst of the complexities of energy usage, Bruce Hannon of the University of Illinois, points out another drawback in shotgun-style efficiency regulations. Companies that now expend energy making their own materials and parts, Hannon says, can achieve huge paper improvements in energy efficiency by simply switching to buying those materials from someone else.

Aside from the new overburden of bureaucracy and regulation that the mandatory approach entails, the substitution of regulations for prices practically guarantees suboptimal behavior. What it would probably do is to lock technology and institutions into their present format—removing the incentive to develop new processes and inhibiting society at large from adopting more energy-efficient arrangements. Without considerable economic incentive, for example, builders will not elect to nestle apartment houses or factories up to coal-burning power plants to share their warmth. Nor is it easy to conceive of any laws acceptable to American society that could force them to do so, except the laws of economics.

3M HAS A BETTER IDEA

All these reasons for being skeptical of mandatory measures don't mean that society—through its government—cannot or should not bring to bear pressures to accelerate conservation, pressures that are stronger than the unaided market alone might muster. Recently, for instance, the 3M Co., in consultation with several other companies and the state of Minnesota, proposed what it calls the "Minnesota Plan." The objective is to reduce energy consumption in the U.S. commercial and industrial sectors by at least 30 percent—the equivalent of about 5.5 million barrels of oil per day—below levels that would otherwise be reached in the coming decade. While the planners estimate that around half that 30 percent could be achieved at little or no cost, the remaining half would require altering or replacing plant and equipment at a cost of around $60 billion.

The key government feature in the Minnesota Plan would be a 25 percent tax credit to companies for expenditures related to energy conservation, plus a same-year write-off. The tax incentives would expire within five years—a provision designed to get companies moving at once. 3M contends that the plan would not even result in any long-term loss of revenues to the government, since the short-term loss would be made up quickly through taxes on the companies' subsequent energy savings.

On its face, the Minnesota Plan appears to have a lot to recommend it, but such proposals may find a cool reception in Congress. Legislators are already worried about appearing to reward industry for conserving energy when everyone else is being compelled to make sacrifices. Yet the plan is preferable to a set of governmental measures that attempt to bully the industrial sector into conserving more energy. A more effective stick to wield—along with the carrot of tax breaks—would be high energy prices.

That stick, as it happens, is acquiring more force with every OPEC price increase and every boost in the ceiling price of "new" interstate gas. Having studied the supply-versus-demand question from various perspectives, the experts now pretty much agree that it generally costs a lot less to save energy than to consume it. John A. Belding, director of conservation research and technology at ERDA, say that, as a rule of thumb, it costs somewhere between a few cents and $1.50 to save a barrel of oil, compared with today's going prices of $11 to $18 to industrial users. Robert O. Reid, vice president of Energy & Environmental Analysis Inc., a consulting firm, estimates that the average after-tax return on energy-conservation investments now lies somewhere between 20 and 30 percent. Thomas F. Widmer, vice president of Thermo Electron, calculates that if the U.S. were to invest $160 billion in conservation measures and another $160 billion on developing new supplies over the next decade, there would be far less of a drag on economic growth than if it spent the $500 billion to $800 billion that economists estimate will otherwise be needed to develop new sources of supply.

The abrupt rise in the marginal cost of supplying new energy—a change that began about 1970, even before OPEC stunned the world with its huge price increases—is the event that will sooner or later trigger a huge new conservation industry. Until 1970, energy consultant Roger Sant points out, the average incremental cost of new energy supplies was about $1.60 per million BTU's, or less than the average price that consumers paid. But today, Sant says, the cost of adding new supplies—exploration, drilling, building power plants, etc.—is in the range of $4 per million BTU's. and the average wholesale price of all forms of energy is being held down to $2.70, primarily by government price controls.

THE COMING INDUSTRIAL SYMBIOSIS

The industrial history of the U.S. has been one of continual dissolution and recrystallization into new patterns. What drives the process is capital depreciation and shifting relative costs of the different factors of production. In the past, many of the changes were energy-related—the replacement of water-powered mills along streams by steam-powered mills in cities and coalfields, the shift of chemical plants to the gas fields of the Gulf states.

The steepening costs of energy seem likely to remobilize this restless process, except that now the only cheap and abundant new sources of energy lie in the vast amount of available but unused work that is discernible through the second law of thermodynamics. The latest episode in the quest after energy may be a coalescence of industry—and perhaps even dwellings—into symbiotic contractual relationships that will allow each participant to nourish itself on that portion of the energy cascade that others can't efficiently exploit. Companies may find, in other words, that the largest, cheapest supply of new energy will be—each other.

E. Growth versus No-Growth: Is Austerity in Our Future?

A GOVERNOR WARNS: LEARN TO LIVE WITH SCARCITY*

(By Richard D. Lamm)

Ours is a national economy, and the thigh bone in Massachusetts is connected to the hip bone in Colorado. Our common vulnerabilities eclipse the regional differences that have been in the news. The latter are not irrelevant. They have generated much heat and some light, and I'm sure the battle will continue to resound fiercely in newspapers and the halls of Congress. Yet one hopes these differences will not overshadow the new international pressures which threaten the entire national economy.

Witness the fact that in the last five years, revolutionary changes have occurred in the availability and prices of minerals, metals, and other resoruces. In the wink of an historical eye, this has moved the ability to set prices and control availability from the consuming countries to the producing countries. The results of this on the American economy are nothing short of revolutionary.

The results of OPEC are well known. The 12 leading oil exporters succeeded in raising their returns by a factor of 10 and in imposing production limitations on the major producers. Other metals and minerals are rapidly falling into a similar pattern: the seven major bauxite producers have formed the International Bauxite Association and significantly increased their earnings; so also the six phosphate producing nations, the coffee producers, banana producers; the list goes on and on.

It is increasingly apparent that we are moving into a time of heavy dependence on foreign minerals and materials. A recent publication of United States Mineral Resources, prepared by the Interior Department Geological Survey, relates the unsettling story that we must import a major percentage of at least 69 to 92 raw materials needed to maintain our present standard of living.

President Nixon appointed the National Commission on Materials Policy made up of resource experts and businessmen. The members recommended, a few years ago, that all industrial nations slow down their consumption of highly depletable resources and move rapidly toward a greater use of the abundant resources. In that same report we were told that before long, as much as half of our supplies of basic raw materials would have to be imported. We are already essentially 100 percent dependent on foreign sources for a number of key materials, such as chromium and tin, platinum and tungsten, which are heavily used in our current technology. Our demand on foreign sources is growing, which is one of the main reasons foreign producers have succeeded in their efforts to start cartels.

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American investments in foreign countries are becoming increasingly subject to nationalization. A recent United Nations survey showed that 875 enterprises in 62 countries were nationalized or otherwise taken over from their original investors between 1960 and 1974. Mines and oil properties were numerically in the minority but they represented the overwhelming proportion in terms of value, and these were largely American-owned. Almost one-fourth of all new investments by U.S. firms now take place overseas, and foreign investment provides a rough equivalent share of U.S. profits.

Thus we find there are some dramatic changes in mineral availability taking place before our very eyes, which will have profound impact on our foreign policy, our domestic policy, our economic system, and our life styles.

Our whole intellectual and social history urges a clear way out of our shortages—a formula of drill, mine, and refine. Pushed by our belief in the infinite and boundless frontiers, we move to solve this problem as we have solved so many others: roll up our sleeves, use our American ingenuity, call on our Puritan heritage, push aside the doubters, and get to work.

However, history has a way of playing tricks on civilization. Yesterday's solutions are not necessarily tomorrow's.

The American West is finding this out. For 100 years, the West has been able to provide water by increasing the supply of water. But with water in the West mostly overappropriated, we are rapidly learning that our future solutions must emphasize demand management. We are bumping into natural constraints, and while some still long for high technological solutions like importation of water from the Yukon these solutions were clearly suggested before the days of the energy crisis. While the route may look downhill on a map, it is uphill most of the way and must be categorized as improbable.

One set of solutions thus runs into another set of problems. Water importation runs into the energy crisis, the energy crisis runs into the capital crisis, and so it goes and goes.

The West thus may have something more important than our resources to share—living with scarcity. We at least recognize the need to make some fundamental adjustments—now. We must move away from defining shortages as supply shortages and see some of them as demand shortages. We must move away from the worship of "more, further, quicker, richer" to an appreciation of the finite. We must learn to consume less, waste less, recycle and reuse more, and make conservation a new cornerstone of all public policy. A society which developed prosperity throughout unlimited natural resources will have to develop new distributional schemes to allocate scarcity. It will test the resilience of our institutions.

The West can still see the track of the Oregon and Santa Fe Trails, made over 120 years ago. We recognize the fragility and limitations of nature. We urge a reexamination of all institutions and habits that automatically assume the use of increasing amounts of natural resources. We are just starting to live with the limitations of our natural resources—but we have at least started. We believe, painfully but unavoidably, it must be the direction of the entire nation.

THE NO-GROWTH SOCIETY—POSTSCRIPT TO AN EPILOGUE

(By E. J. Mishan)*

It is hard to believe that, only ten years ago, doubts about the benefits of continuing economic growth would have been regarded as tantamount to doubts about the ultimate beneficence of progress itself. After all, the continued expansion of our productive powers was generally believed to be an essential pre-condition of progress toward the good life of leisure and abundance toward which, presumably, all civilised people aspired. Today, this presumption in favour of economic growth has all but vanished. Indeed, casual reflection suggests that the reaction has gone too far. Writing my *Costs of Economic Growth* in 1965, I had to weigh my arguments carefully in the expectation that my colleagues in the economics profession would be quick to seize on the weak links and the implicit judgements. No need to be so cautious today! One can rail indiscriminately against the spread of industry and the depredations of technology without fear of being taken to task. There is, if anything, a need for an intelligent *anti*-anti-growth movement, if only to compel the anti-growth bandwagon to examine their arguments more carefully.

Among economists and other social scientists, sporadic debate on the issues raised by the concept of sustained or sustainable economic growth began about six years ago. To the interested reader, the essays brought together in the recently published volume, *The No-Growth Society*, edited by Mancur Olson and Hans H. Landsberg (Woburn Press, £2.25) can be recommended as a fair sample of the uneven style and quality of the contributions to the ongoing debate. If he is not *au courant* with the writings, pro and con, on the growth topic, the reader will be glad to know that the short Epilogue written by Joseph Fisher, along with the editors, Mancur Olson and Hans Landsberg, offers not only a summary but also a good starting point. At any rate, I propose to paraphrase their observations there before appraising them.

Although the authors of the Epilogue are determined to be fair to the anti-growth movement, their partiality is revealed by too ready a recourse to that manner of exposition customarily reserved for describing the beliefs of well-meaning sectarians who have not yet seen the light, or seen it imperfectly. Thus, their playful grouping of the opposition into *ecofreaks*, *sociofreaks*, *psychofreaks*, and *safety-freaks* (in apology for which license they append a longish footnote, arguing the convenience of the shorthand while disclaiming its connotations) inevitably suggests that the anti-growth-man, whatever his reasons or motives, sees but one side of the problem, whereas they, the authors, see it whole and in the round. The mere adoption of such a scheme also partakes of a stratagem, and one can safely predict that their brief excursion, guided by the signposts, will culminate in some utterance of consummate prudence. In the event, the message that emerges is one currently popular among the elder-statesman type of economist—that growth be not jettisoned, but given a new direction

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*From Contemporary Review, Vol. 227, No. 1317, October 1975, p. 169–177. E.J. Mishan is a Professor of Economics at the London School of Economics and Political Science. Reprinted by permission.

Following the authors' exposition, the *ecofreak* is characterised as a person having 'an intense, uncompromising, and moving devotion to a lovely natural environment', which description, incidentally, makes him a slightly pathetic figure also. However, the 'rational ecofreak' is not against economic growth *per se*, since proper regulation of industry would result in sacrificing only some part of the increase in economic growth in exchange for preserving, or even improving, the environment.

The *sociofreak*, 'like the ecofreak, is not used as a term of abuse, but rather as a characterisation of an extreme, but not neecssarily mistaken, value judgement'—examples of these 'extreme' values being the belief in family, and in friendship and trust. He is distinguished from the ecofreak, however, in being concerned mainly with the interactions of the social system rather than with those of the ecological system. The sociofreak's lack of perspective is further illustrated by his attraction to the notion, enunciated by Durkheim, that individuals 'need extensive ties to bind them to the social order, and that these ties must have at least some degree of stability'. Since rapid economic growth is disruptive of such attributes, it is repudiated by the *sociofreak*.

The *psychofreak* is given to the belief that when 'wealth accumulates, men decay'. Consequently, he abhors the habit of mind associated with economic growth, such as calculation, specialisation, acquisitiveness. He also deplores the loss of the sense of mystery and awe, and the respect for elders, associated with traditional societies. Nevertheless, the distaste of economic growth among the young, and the current fashion for mystreious cults, witchcraft, and hallucinatory drugs, is explained by the author as being itself a product of affluence, in so far as it offers the young the leisure and wherewithal to indulge their whims.

The *safety-freak*, the last of this errant fraternity, can also be an ecofreak, though one that is fearful that continued abuse of the environment will lead to disaster and, possibly, to the destruction of the planet. Being aware of 'the unfathomed complexity of the ecological and economic system, and of their relationships to each other', he anticipates significant risks arising from any new non-degradable residuals which appear innocuous 'until it has accumulated to a toxic level, progressed up the food chain, and been identified as the source of some undiagnosed malady'. Thus, some of the unanticipated ecological side effects of economic development may turn out to be as irreversible as they are intractable.

The misgivings of the safety-freak, in particular, are cogently presented by the authors. They point out that the 'materials balance' approach to environmental problems, developed by economists Ayres and Kneese, by Kenneth Boulding and others, affirms that the weight of materials taken into the economy as finished goods is equalled by the weight of the resultant wastes or residuals (allowance being made for recycling and net accumulation). Therefore, economic growth, as conventionally conceived at least, cannot but increase the amount of residuals in the environment. In other words, the pollution problem is inherent in the increasing material throughout and energy consumption of a growing economy. The question is not *if*, but *when*.

Finally, they recognize that antigrowthmen do not anticipate prompt and effective responses to environmental problems to emerge from the existing establishment. Since industries that have strong commercial interests in continuing their local pollution create far more effective political lobbies than the initially more diffused interest of the general public, democratic society may persist for a long time in policies that are manifestly pernicious.

Although the case put for the anti-growth movement by the authors is a fair one, it can be strengthened by considerations arising from some further scrutiny of their arguments.

The classification adopted is, of course, functional rather than personal; it does not, that is, correspond to real groups of people but serves rather to sort out the arguments into separate pigeon holes. Even so, the difference between ecofreak and safety-freak attitudes is hard to maintain. Any genuine concern for the environment can hardly divorce itself from the associated concern with ecological effects, in particular with the increasing hazards arising from the speed and scale of man's intervention in the biosphere. Indeed, their 'rational ecofreak', who is not against economic growth *per se*, invites consideration of the conditions under which per capita growth could continue despite the incidence of environmental damage.

Sufficient conditions would be (a) zero population growth, (b) an ability to foresee the full range of consequences arising from new industrial processes and products, and (*c*) a society wise enough to forbear from certain forms of research or economic activity, and to act in time to reallocate resources and otherwise regulate the unavoidable overspill of continued economic growth.

Even if these ideal conditions were met, the resulting per capita growth could not be very much, or could not last very long. As the authors point out, the weight of residuals poured into the biosphere is about equal to the weight of the goods used up in producing the economy's net product. Therefore, if per capita growth (as conventionally measured) is to be maintained, the total amount of residuals will continue to increase—although a trend toward an increased proportion of services in aggregate expenditure, it is often alleged, would imply a slower rate of increase in the total amount of residuals.[1] Since the 'treatment' of a pollutant entails displacing its location, or transforming it into another supposedly less harmful substance, the total residuals continue to accumulate until, in one form or another, they cause damage or disaster.

And we are not talking simply about a doubling or trebling of the existing amount of residuals in the biosphere. An average 3 per cent per capita growth—modest in the light of the post-war performance of the industrialised countries—maintained, say, for 500 years, would produce a per capita income one *million* times as great as that enjoyed by today's affluent citizens. The attempt to imagine just what form the pattern of expenditure of this future citizen will take—he will not surely own a million cars and a million houses!—and the space needed to accommodate the resulting plethora of goods and gadgetry is enough to make the most hopeful growthman sceptical of ever attaining so fantastic a standard. But once we contemplate the rate of depletion of the earth's finite resources, and the weight of residuals involved in maintaining such a standard,[2] to say nothing of the waste heat from the energy needed to produce the goods, the possibility has to be dismissed as absurd.

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[1] So far as I know there have been no studies to indicate that the production of services rather than products is less wasteful of materials and energy. The sort of services that come to mind in this connection, travel and tourism, catering commerce, education, recreation, medical services, all happen to absorb exorbitant amounts of capital equipment.

As for that part of economic growth that would be described as an increase in leisure, it is an important ingredient of social welfare that is disregarded by the conventional indices of 'real' per capita growth. Of course, if all future growth were taken out in the form of leisure, the remaining physical product (the aggregate amount of materials and energy used) being a constant through time, there would be no immediate problem. We are, however, concerned here with the aspirations of growthmen and technocrats who, although they anticipate a continuing trend toward a shorter working week, envisage a sustained growth also of man's productive power and material resources.

In the light of these considerations it seems more sensible to regard a prolonged period of economic growth as an abnormality. We have had, at most, 200 years of it. Prior to that episode, there were millennia during which per capita growth rose and fell many times as civilisations coexisted and alternated with periods of barbarism, but without establishing any perceptible trend.

Returning now to the three conditions posited above, it is hardly necessary to remark that their fulfillment is in any case impossible. The world's population is, indeed, increasing. All indications point to a world population of between 6 and 7 billion before the end of the century—if not checked by famine or internecine warfare. What is more, the environmental damage caused by population growth alone necessarily reduces per capita welfare no matter how well resources are reallocated.

As for man's ability to foresee the consequences of his innovative activity, the authors themselves agree that it is, in the nature of things, quite impossible. Each year, for example, hundreds of new chemicals—drugs, pesticides, synthetics, food-additives—come onto the market, adding themselves to the inventory of those having (singly or in combination) possible ecological or genetic consequences that we can only discover with the passage of time. The probability that one single chemical substance, alone or in combination with others, could result in some irreparable disaster may be slight, as is often alleged. But as the number continues to grow year by year, the probability of some disaster occurring approaches closer to a virtual certainty.

Turning to the last condition mentioned, we observe again, that the authors are openly sceptical of the likelihood of a really effective response from a democratic society to the problems of environmental pollution. Indeed, Mancur Olson's own classic work, *The Logic of Collective Action*, develops the necessary economic theory that explains so nicely just why the concerted interests of small groups tend to prevail over the diffused interests of society at large. And some evidence of particular relevance is provided in a recent article, *Clean Rhetoric: Dirty Water*, by two economists,[3] who were forced to the conclusion that the widespread antagonism of industry which defeated the proposed 'effluent tax' in the U.S. was attributable, in the last resort, to its anticipated efficacy in the control of industrial pollution.

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[2] Technological progress does, of course, comprehend innovations that reduce the resources required to produce outputs yielding equal consumer satisfaction. But judging by the experience of the last 200 years, an x per cent increase of per capita 'real' input entails an increase in energy and material resources not much less than x per cent. Thus, if a mere hundredfold increase in our productive powers (as conventionally measured) were obtainable for a fractional increase of energy and material resources—say, one-quarter, or even one-tenth—the magnitude of the resulting residuals would still be virtually unmanageable.

[3] A. M. Freeman and R. H. Haveman, in *The Public Interest*, Summer 1972.

In view, then, of the increasing risk to which humanity is exposed, the idea of curbing our growth ambitions may not be so eccentric after all, even though it still runs counter to official views and to entrenched interests, material and intellectual. Certainly, some social gains could be realised by successful adjustment to a steady-state society. For those 'extreme' or 'eccentric' values imputed by the authors to the sociofreak and psychofreak—their emphasis on the sense of mystery, on the family, on respect for elders; their deep want of a settled way of life, and their belief in the importance of friendship and trust arising therefrom—are surely no more and no less than *traditional* values. Indeed, it is hard to discover any other set of values that are so widespread or so deeply ingrained even in affluent societies.

Perhaps what the authors meant to convey was that the pursuit of current social aims—such as an expansion of educational and economic opportunities; an increase in mobility, geographical and social; continuing improvements in efficiency and in the production of material conveniences—generates unanticipated social effects, among which are an increasing preoccupation with material status, a growing restlessness and discontent with one's lot, and, therefore, unavoidably, a frustration of those aspects of life expressed in traditional values. In other words, a conflict currently exists between the *actual effects* on our communal character and style of life arising from pursuit of objects associated with continued economic growth, on the one hand, and, on the other, the *desired* communal character and style of life that reflect our deeper humanity and which is, I believe, expressed in our traditional values.

Let us, finally, consider the conclusion reached by the authors, in the list two paragraphs of the *Epilogue*, since its intent is to come down (albeit marginally) in favour of continued economic growth. As they so disarmingly phrase it, the aim should be 'to reform rather than prohibit growth' as this is far better for 'the great majority who eschew extreme values'. This terminology is, of course, the stuff out of which good presidential addresses are fashioned. But since they offer no instruction on just how growth is to be reformed, other than a remark about 'making the composition of output more attractive',—a benign proposal that, incidentally evades all the chief problems associated with an economic growth that is fuelled, principally, by technological innovation—we have, perforce, to move on and examine the only two arguments that can be culled from these last paragraphs.

Their first argument is that continued economic growth is still desirable for those whose poverty leaves them with an intense need for additional market goods'.

Now this sounds eminently reasonable until we pose the question: How much more economic growth in already affluent societies[4] is necessary to alleviate the indigenous 'hard core' poverty? The average annual increase of national product in the U.S. is currently about $50 billion, an amount that would surely suffice to remove the physical want of the really destitute. Indeed, a few years of such economic growth would suffice to remove not only all degrading poverty (however defined) in that country, but should be more than enough to provide also all the 'merit' goods—those museums, art galleries, symphony orchestras, high institutes of learning, better clinics, and the like, that so easily trip off the tongue of our ingenuous growthmen who are eager to sperad the impression that the sustained economic growth objective is really a sort of unending charity ball.

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[4] The debate that interests many of the contributors to this volume of essays, and many economists today, turns on the possibility and the desirability of continued economic growth in the already prosperous countries of the West. None, of course, would deny the pressing problems of the poorer countries of the so-called Third World; nor that some improvement in their living standards is desirable. What improvement, if any, is possible given their continued population growth, is a question I do not consider here. But whatever the answer, it does not qualify any of the observations made above on the problems that must arise in the endeavour to continue economic growth for a prolonged period at rates anything like those currently regarded as feasible.

But is it *politically* feasible? Hardly! Therefore, conclude our growth men, economic growth has to continue—which is tantamount to saying that we can, in reality, do a little more for the really poor, and for all other worthy causes, only by continuing to do a lot more for ourselves.

The logic of this example of 'enlightened self interest' is particularly revealing. The fact that even when there is everywhere manifest evidence of over-indulgence, absurd ostentation, and almost criminal waste, the citizens of the affluent society cannot collectively agree to curb their extravagant expenditures by a small fraction so as to alleviate the wretched poverty of a tiny minority of their countrymen, is itself directly connected with the process of economic growth. For this institutional or political constraint springs directly from an ethos that is favourable, indeed essential, to economic growth, an ethos that is simultaneously promoted by economic growth. To be more explicit, the pursuit of economic growth over the years has been maintained, and will continue to be maintained, only by the priority given by citizens to self-seeking and self-promotion. And if that self-seeking and self-promotion is aggravated by the discontent and ambition generated by the system, then the resulting 'institutional' or 'political constraints' that make such 'ethical transfers' unfeasible are among the more shameful products of economic growth.

The second argument deployed by the authors, one related to the first, is that of the risk of *not* continuing growth. So long as economic growth can be maintained, they observe, net material gains will accrue to society which can be used to mitigate conflict. In a no-growth society, in contrast, one group's gain must be some other groups' loss. And so, they conclude, 'the fights, presumably, would be mighty rough'.

Inasmuch as the fighting between different segments of the community today already look 'mighty rough', the risk of yet more intense conflict should, indeed, give us pause. But then, we need not pause long before recognising the argument to be bogus.

Examples of the difficulties that arise in an economy that does not grow are always taken, by growthmen, from the short-lived periods of economic stagnation suffered by Western countries. They include such unhappy features as a rise in the number of unemployed workers, a decline in the share of labour's income (except perhaps during the more prolonged depression of the early 1930s), acute hardship among the poorest section of the populace, a general frustration of people's expectations, and increased conflicts within the working class. Yet these recessional features are not, as it happens, at all pertinent to the issue.

They are peculiar to a growth-bound economy, one in which a period of no growth, or a decline in growth, arises from 'market failures' or inadequate monetary and fiscal policies and, therefore, necessarily entail unemployment and 'stagnation'.

Now, the no-growth movement is concerned primarily with the quality of life. Its proponents have never advocated the creation of unemployment *within the growth economy* as a means of realising a steady-state or no-growth economy. Rather, they seek to persuade the public to abandon altogether the pursuit of economic growth in favour of the steady-state economy, within which there are to be institutions for the explicit and prolonged consideration of ways of reducing material input while enhancing the enjoyment of life. The detailed measures whereby a steady-state low-energy economy can be brought into being (the rationing of raw materials, the controls on technology and on the marketing of its products, the level of affluence to be aimed at, and so forth) are important subjects of discussion. But they are premature. Immediate concern is with the revolution in thought and feeling that is necessary if men's aspirations toward the good life are ever to be realised.

Thus, the aim of the no-growthman is not a no-growth economy *per se.* His aim is the *acceptance*, by the public at large, of a no-growth or steady-state economy. Once the ethics of a no-growth economy are accepted by the public at large, and the notion of a competitive striving for more, ever more, becomes a thing of the past, it will be that much easier, incidentally, to remove that wretched poverty that still lingers in Western countries, and to maintain a more equitable distribution of income.

In conclusion, let me advance an alternative framework around which we can organise our reflections on the problems raised by continued economic growth. There is, of course, an obvious division between the problems relevant to population growth and those relevant to per capita growth, even though some problems, chiefly environmental and ecological, may be common to both.

Those problems pertaining to per capita growth are, I believe, the more intellectually challenging ones, and I suggest a classification of the issues they raise under three main headings: (1) The growth of the commercial spirit, (2) the cult of efficiency, and (3) the shape of technology.

In connection with the first heading, we tend to think of the 'mixed' economies of the Western democracies, and of the institutionalised discontent that is the mainspring of the system. The post-war emphasis on material expectations, and the mass of invidious statistics provided by modern media, are among the more salient consequences. They have culminated today in a national obsession with position in the pay structure. In the last five years, the British people seem to have transformed themselves into corps of pay vigilantes. The struggle for position in the pay queue, and the envy it inflames, seem to suggest that only an egalitarian society would be regarded by the nation at large as tolerable.

In contrast, among the factors to be subsumed under the second heading, is the trend toward a meritocracy. The social and political struggle in the West arising from the clash of these opposing currents—the egalitarian and the meritocratic—is a thesis in itself, though one that we cannot pursue here. Under the same broad heading we place the extreme division of labour and the fragmentation of skills into further specialisations in the cause of that perpetual search for improved efficiency and goods innovation, accompanied as they are by the unavoidable lengthening of vocational training periods needed to maintain the scientific and technological momentum. The importance of these factors on the human psyche has been emphasised by many writers, including economists, since the beginning of the 'industrial revolution'. Although their scientific analysis is difficult, there can be little doubt that they act to cramp spontaneity of feeling, to dull the sensuous perception of life and are generally corrosive of a sense of well-being.

The growth of secular education, moreover, fosters an eclectic scepticism that erodes belief in the great myths and drains the foundations of a moral consensus. In this way it dissipates those sources of hope and faith that, since the dawn of history, have sustained ordinary people in their trials and misfortunes. In the circumstances, it would be extraordinary if there were no connection between sustained economic growth in the West and the incipient disintegration of its civilisation since World War II, as revealed by the relentless climb of the official indices of divorce, drug-taking, suicide, vandalism, theft, homicide, and crimes of increasing violence, especially among the young. It is far from certain that in the scale of human welfare, the accumulation of material conveniences outweighs the growing sense of insecurity and the consequent fear and anxiety.

It is, under the third heading, however, that the most interesting material will be found, material which, until very recently, has been almost entirely neglected by economists. For by training they are concerned more with the conditions under which goods are produced, and the means whereby they are distributed, than with the actual sort of goods themselves, both capital and consumer goods, and their far-reaching effects on our environment, on our character, and on our chances of survival. Despite the increased powers they have conferred on ordinary mortals, most of the popular innovations of the last fifty years, from the motor car to the television set, from domestic labour-saving gadgetry to recreational toys, have turned out also, perhaps inevitably, to be the elegant instruments of our continuing mutual estrangement. And despite 'miracle drugs', 'wonder flights' into space, and other 'exciting possibilities' eagerly anticipated, the human race is being impelled by an irresistible tide of scientific discovery into an ocean mined thick with new perils. If we survive at all, it will only be in consequence of a vast extension of government controls and a concomitant decline of personal freedom.

The charitable reader will pardon me if I do not end on a note of hope—or a suggestion, at least, of some means whereby the human race might escape the ignominious fate which appears to be its destiny. This omission is not, however, to be attributed to lack of space or of imagination, but simply to lack of faith. The kind of wisdom and will that is needed to move humanity away from its current obsession with forcing open the secrets of the universe, in a supreme bid for god-like power, just cannot be mustered within the institutions of the modern world.

NO GROWTH HAS TO MEAN LESS IS LESS

(By Bayard Rustin)*

There is an immense contradiction at the heart of the political attitudes of many Americans—those for whom the abolition of poverty and racial inequality rank together with environmental protection as the highest social priorities of the immediate future. The vast majority would agree that the country is now facing a historic national crisis. There is mass unemployment, a sizable and expanding black underclass comprising persons whose lives were scarcely touched by the civil-rights revolution, and a declining standard of living for millions of working people. Yet many of those who profess concern about unemployment and poverty also actively support the concept of limiting economic growth in order to protect the environment. That notion, if translated into conscious policy, would measurably worsen the nations'—and the world's—economic plight. And its promoters would bear the responsibility for having shattered the hopes of those who have never had a normal role in the world economy, among whom the darker-skinned people of the world rank most prominently.

This exaggerated and misplaced disillusionment with economic growth has been based on the premise that America has achieved an unparalleled state of prosperity such that economic needs and insecurities are no longer the principal concern of its people. With an official (and understated) unemployment rate hovering around 8 percent, and with key sectors of the economy engulfed by Depression-era stagnation, one hears less today about America as the "affluent society" than in the not-too-remote past. Yet that most unfortunate phrase—"affluent society"—has left a permanent imprint. It has provided the rationale for a whole series of attitudes, movements and policies that share a crucial assumption: The material standards of the American majority have reached a level of affluence so substantial as to render the further expansion of production and wealth unnecessary and undesirable. Many of these modern disciples of Thomas Malthus believe that their long-range vision of a better society can be fulfilled only by severely restricting or preventing altogether further economic expansion. E. J. Mishan, a professor of economics at the London School of Economics, has compared the further pursuit of growth to a "joyless voyage, fraught with increasing risk, and bound for an unattractive destination." While Mishan is usually described as a "conservative," the fact is that his crusade against technological society—including proposals for a ban of international air travel and for creation of communities where only horses and horse-drawn vehicles would be permitted—has struck a responsive chord with many American ecologists.

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*Appeared in the New York Times Magazine, May 2, 1976. © 1976 by the New York Times Company. Reprinted by permission. Bayard Rustin was President of the A. Philip Randolph Institute and national chairman of Social Democrats, U.S.A. at the time this article appeared.

It has long been an article of faith for conservative economists that accelerated rates of growth are a chief cause of inflation. When conservatives have held the Presidency, their advisers have often encouraged fiscal and monetary policies aimed at slowing growth and increasing the jobless rate as a means of reducing the pace of inflation. This was the case during both the Eisenhower and Nixon Administrations—and it is now the case for the Administration of Gerald Ford.

What is different about the current upsurge in antigrowth sentiment is that the bulk of its intellectual and political advocates characterize themselves as liberal, or even radical, in the sense that they maintain in the abstract a conviction that it is the Government's obligation to assure a condiiton of equality for all people, and to intervene actively on behalf of the poor and minority groups.

To its credit, the environmental movement has made a significant contribution to the struggle for a more humane social order by forcing society to take a new look at many previously accepted patterns of economic and cultural behavior. In its most praiseworthy campaigns, the environmnetal movement has sought changes that are of great importance to working people. It can take credit for having reawakened society to the need for more stringent job-safety regulations. By pointing out that it is the neighborhoods of the poor and working classes that receive the worst effects of pollution from nearby plants, it has added an important class dimension to the struggle for a cleaner environment. Environmentalists can also take credit for having questioned the usefulness of the urban renewal schemes, highways and developments that so often require the destruction of healthy working-class neighborhoods. At the same time, many of those in the vanguard of the environmental movement, themselves members largely of the upper classes, have often sought policies that are clearly dertimental, and in some cases—the growth controversy being the most significant example—destructive to the needs of those less better off.

The antigrowth movement has already made its impact felt in the debate over economic recovery that occupies a central role in the Presidential campaign. The attitude of many liberal Democrats is strikingly different from that of John F. Kennedy, who made the cautious, slow-growth policies of the Eisenhower Administration a decisive issue in 1960. Confronted by an economic crisis far more severe than the problems facing Kennedy, many liberal Democrats prefer the motto "less is more" to Kennedy's ringing assertion that "a rising tide lifts all the boats."

Let me make it clear that I am in general sympathy with the two basic elements of what is shaping up as a new liberal agenda for economic transformation. The first element, publicly financed jobs, is desperately needed not only to reduce unemployment, but also to enable the Federal Government to carry out the vital programs of urban reconstruction that business and the states and cities will not, or cannot, carry out. The second, the dismantling of the largest corporations through vigorous antitrust enforcement, as proposed by politicians like Fred Harris, can be a useful mechanism for reducing the inordinate influence of corporate giants and conglomerates. (Though we may be deluding ourselves if we look on trust-busting as a means of putting people back to work. Critics of "bigness" seem to forget that the competitive capitalism of the past bred a degree of worker exploitation that is unimaginable today.)

But these are not, by themselves, a sufficient response to high, long-term unemployment or to the problem of the hard-core, structurally unemployed. Sustained, high economic growth is also a precondition for the creation of a more equal society. For as economist Leon Keyserling points out, it has been only during periods of high growth that America has made forward thrusts against mass poverty and unemployment. In a direct response to the critics of growth, Keyserling writes:

"The record is clear beyond question that there is a high positive correleation between the rate of real economic growth and the rate of reduction of poverty. This is mainly because the high unemployment attendant upon how low growth *is the main single cause of poverty.* A second reason is that the improved income distribution and the larger emphasis upon the great domestic priority programs, which in part derive from high growth and in part are essential to it, are also indispensable to the liquidation of poverty [emphasis added]."

The point about the correlation between growth and the effectiveness of social programs is crucial. For in the opinion of many critics, economic expansion, while raising the standards of the working class, has totally failed to reduce poverty, particularly among blacks. Yet the record shows that this is simply not the case. Between 1959 and 1969—a period of transition from policies of slow growth to those of relatively high growth—the percentage of white families earning less than the Federal low-income level shrank from 18.1 to 9.5 percent, not an insignificant amount. For blacks, the change was even more dramatic: The proportion of blacks living in poverty declined from 55.1 percent to 32.2 percent. In other words, whereas at the beginning of the decade more than one-half of all blacks lived in poverty, by the end of the decade that number had been reduced to less than one-third.

A healthy rate of economic expansion is a precondition for the success of manpower and service programs that are directed to the special needs of the poor. Without substantial growth, we simply will not have enough jobs for those individuals who have undertaken training programs as a means of overcoming the effects of poor educational opportunity. Nor will Government have the resources to build the housing, supply the medical services, and upgrade the schools in the inner cities.

Perhaps even more important would be the psychological and political effects of restricting or stopping growth. People who are confronted by scarcity and a declining standard of living are unlikely to lend support to policies that seek to lift the standards of only the very poor. Hard times do not evoke a national consensus for massive reform; the cycle of recession/inflation/stagnation engineered by successive Republican Administrations has hardened the politics of envy and selfishness.

In addition to its impact on domestic politics, the abandonment of growth would have an incalculable effect on our foreign relations. The role that America plays in the coming struggle to free the underdeveloped world from its pervasive and oppressive cycle of economic bondage poses one of the great challenges of the future. Without growth, we could never mobilize domestic political support for policies that offer new hope to the emerging nations. But even more important, economic growth in industrial countries is of major economic benefit to poorer countries who need markets for their raw material resources and other products.

Nevertheless, in the face of overwhelming evidence that the end of growth would result in an incalculable set-back for poor and darker-skinned peoples of America and the world, the antigrowth proponents stubbornly insist that the perpetuation of current rates of economic expansion can only hasten the destruction of humankind. And they do so despite the fact that some of the most fundamental tenets of the neo-Malthusians—such as the notion that much of the earth's natural resources face extinction by the end of the century—have been sharply criticized by scientists and economists who believe that the earth can sustain growth rates sufficient to make possible the abolition of poverty in even the most wretchedly destitute African or Asian nation.

If the scientific rationale that underlies the antigrowth movement is by no means proven, why has the limits-to-growth thesis won such wide-spread acceptance? One suspects that there is a certain class disdain at work in the anguished cries over materialism and overabundance, and that what many critics of growth are really upset about is the loss of status that the privileged suffer with the enlargement of the middle classes. Such attitudes, it should be noted, are by no means limited to the opposition of segments of the traditional elite to economic democracy. At the core, the factional struggles within the Democratic Party are the strivings of an educated, middle-class elite for domination over organized labor and the working class. Lacking a mass constituency, this elite has fallen back on an exquisitely honed sense of self-righteousness and moral sensitivity—it has, in other words, claimed authority on the grounds that it comprises the better, more enlightened people—to place its adversaries on the defensive. Anthony Crosland, the brilliant social democratic theorist who is current Foreign Secretary in the British Labor Government, has written a biting rejoinder to such attitudes. He says:

> My working-class constituents have their own version of the environment, which is equally valid and which calls for economic growth. They want lower housing densities and better schools and hospitals. They want washing machines and refrigerators to relieve domestic drudgery. They want cars, and the freedom they give on weekends and holidays. And they want package-tour holidays to Majorca, even if this means more noise of night flights and eating fish and chips on previously secluded beaches—why should they too not enjoy the sun? And they want these things not . . . because their minds have been brainwashed and their tastes contrived by advertising, but because the things are desirable in themselves.

Crosland here does not even get into what is perhaps a more fundamental prejudice held by the antigrowth intelligentsia—a contempt for the very occupations that would be most threatened by a reduction in growth or by the imposition of extreme environmental restrictions. The jobs that would be lost would be almost exclusively in blue-collar fields—jobs that can be repetitious and deadening to the spirit, but that can also offer a challenge to the ingenuity and skills of a worker, as with construction work. Environmentalists can talk glibly about creating opportunities for the "retraining" of workers displaced by antipollution regulations, but the response of the worker is likely to echo the trade unionist who observed that he had "never met an unemployed environmentalist."

I do not here wish to exaggerate the impact of environmental legislation on the jobs of working Americans. According to estimates of the Environmental Protection Agency, some 12,000 jobs have been lost due to plant closings and the like mandated by stiffer pollution standards. Environmentalists are quite right to point out that many more jobs have been created by antipollution projects—such as sewage treatment facilities—than have been lost because of the failure of a firm to comply with Government antipollution laws. Nor do I wish to appear sympathetic to those antienvironmentalists within the business community who regularly issue sweeping and unfounded protests that business is being "strangled" by overregulation. Businessmen have resisted the imposition of antipollution standards for the very same reasons they have resisted civil-rights laws and labor legislation—a class-rooted antipathy to government intervention in business affairs—and not because of an inability to comply with needed changes.

But environmentalists are also guilty of obscuring the effects of their agenda. Plant closings have eliminated some actual jobs, but the curtailment of construction projects, industrial enterprises and agricultural ventures for environmental reasons has eliminated many more *potential* jobs. This problem is of particular importance to poor blacks in the rural South, and there have been several lawsuits involving Southern civil-rights forces and environmentalists over the question of rural development. Furthermore, a report prepared for the Department of Health, Education and Welfare on the economic implications of air-quality legislation suggests that the long-term effects of stringent antipollution laws could have serious long-range effects on the development of the rural, black South. That report notes: "While nondeterioration regulations risk imposing substanial net costs on the nation as a whole, a disproportionate share of these costs might be borne by persons of limited economic means and residential mobility. These persons would benefit relatively little from the preservation of air quality in rural areas, while they would disproportionately bear any burdens of curtailed economic growth, altered urban and rural development trends, constrained national capacity to absorb anticipated population increases, and higher consumer prices of manufactured goods. These impacts could compound the difficulties faced by all levels of government in responding to the needs of the poor, the elderly, racial minorities and persons otherwise disadvantaged."

The implications of this report, at the very least, suggest that harmonizing environmental objectives with the need for economic development is a far more complex challenge than many have supposed. It is thus no wonder that the advocates of a zero-growth, "stable state" future are so purposely vague about how, within this context of diminishing opportunity, justice can be won for the very poor. Some, of course, do have a program: massive redistribution of income and wealth achieved largely through the thorough-going change of tax policies. Tax reform is, of course, a goal that is important for reasons of equity and fairness, as well as for the benefits it might provide for the poor. But recent history has demonstrated clearly the limitations of the politics of redistribution within a slow- or no-growth society. I would recommend a careful examination of the experience of the British Government during the past few years. Although it would be unfair to equate Britain's manifold problems with those of other Western nations, there is still an important lesson to be learned: Policies that seek to transfer wealth from the affluent and middle classes to the poor and working classes—if carried out under conditions of stagnation—cannot prevent, and may in fact contribute, to the declining standards of all the people, rich and poor alike. In contrast, countries like West Germany and Sweden, with forward-thinking social democratic Governments, have elevated the standards of their citizens, kept unemployment to a minimum and largely abolished poverty precisely because they have chosen to emphasize production and growth while at the same time using the fruits of growth to provide more and more efficient services to their people.

While the United States has had no experience with the politics of redistributionism similar to that attempted in Britain, we *have* witnessed the effect of the kinds of policies that seek the exclusive advancement of social groups suffering from past or present discrimination; policies, moreover, that represent an attempt at redistribution through a form of "social engineering." The most controversial of these policies is the imposition of racial quotas in the hiring programs of businesses, construction trades unions, universities and the like. For the individual who no longer believes economic growth to be an enlightened or feasible approach to the problem of income inequality, quota systems represent an obvious solution. And, indeed, were a zero- or slow-growth economy to obtain, we would no doubt confront increasing demands for some form or another of quota hiring in order to ration the pieces of a shrinking pie on a more racially and sexually equal basis.

There are any number of reasons to oppose the employment of quota systems, including the persuasive argument that they simply don't work. A more fundamental objection, however, is that quotas really solve nothing; indeed, they create many more problems than they might be expected to resolve. If jobs are scarce, apportioning them to one group on the basis of racial or biological characteristics means denying employment to other individuals because of their racial or biological characteristics. For some people, such a procedure is entirely acceptable, since they are convinced that whites or males have not won their jobs out of ability or intelligence, but because they are members of a "privileged" class. Of course, they are correct to point out that white men have a disproportionate share of good jobs because of practices and prejudices that have long been rooted in our culture. But it is no solution to substitute one form of discrimination for another; two wrongs do not make a right, as the quota proponents seem to believe.

More to the point, what sort of a society does the future promise should we surrender the single most effective means of dealing with the problems of the slum proletariat? This underclass either has no relationship to the production of goods and services, or is trapped in marginal, dead-end occupations. We may, in fact, be witnessing the emergence of a class of "economic untouchables," an entire generation of largely black youth who have been deprived of the opportunity to enter the work force in a meaningful way and who, in despair may simply abandon the hope of ever taking part in the economy.

To some, the current attack on growth is simply the latest of intellectual fashions. I disagree. Far from being a passing fad, the willingness to abandon growth at once symbolizes and contributes to the weakening of liberal will and liberal vision in the West. Above all else, liberals have fought for a society that offered an ever increasing possibility for the fulfillment of individual potential within the context of a just legal and economic order. The failure to achieve perfect justice and perfect opportunity should in no way obscure the very real progress that has been made toward these ideals. Not the least of these achievements is the perpetuation of a democratic form of government that, whatever its flaws, has permitted ordinary people to have a voice in, and sometimes to dominate the political systems. It is, furthermore, a system that has reduced the influence of privilege without coercion or purges. Now we are told that the byword of the future is to be retrenchment, that we will have to make do with less, even though, we are assured, a future with less will be superior to the present. Better for whom? Not, certainly, for those who now have little. Not for the citizens of the third-world nations, who alternate between despondency and desperation.

There is still a challenging agenda of worldwide economic advancement ahead, and it is an agenda on which the future of humankind rests just as surely as our future depends on the protection of the air and water. To those who insist that we can no longer tolerate economic growth, my response is simply that we cannot afford to do without it.

HANDS OFF THE FUTURE: THE CASE AGAINST NO-GROWTH PLANNING

(By Jib Fowles)*

For 200 years the United States of America has been at the vanguard of industrial advance, devoting itself to ever greater productivity. Now, in the last five years, this momentum has been loudly called into question. A number of futurists believe that continued growth will lead to catastrophe. The solution, they argue, is to constrain economic growth now.

The no-growth proponents feel that the earth would in effect have to be eaten up if the voracious processes of industrialization are to be supplied in the future. What these processes give forth, for all the raw materials committed to them, is frequently offensive in their eyes—meaningless trinkets, and sometimes deadly weapons. The effluvia which are also produced may well come to stifle life, they claim. The social distortions which they credit to industrialization are equally repugnant: runaway population growth, and a growing breach between the "haves" and the "have-nots."

These dangers are strikingly depicted in three highly-regarded works: *The Limits to Growth* by Donella and Dennis Meadows *et al* (Universe Books, 1972), Robert Heilbroner's *The Human Prospect* (W. W. Norton, 1974), and Victor Ferkiss' *The Future of Technological Civilization* (George Braziller, 1974). All three begin by assuming their readership also agrees that mankind is in terrible straits. The Meadows book is subtitled "The Predicament of Mankind." Heilbroner says, "I shall simply start by assuming that the reader shares with me an awareness of an oppressive anticipation of the future." Ferkiss launches himself with the skimpiest statement of the problem. Readers who do not wholeheartedly share in their broad and unquestioned premonitions may be left behind at the outset.

The "world problematique," as it is called in *The Limits to Growth*, will bring civilization to a grinding halt in the next century at the latest, the authors say. The simulation model described in the book foresees this happening as the planet's resources are consumed, pollution becomes overwhelming, and population outstrips food supply. The way to stave off catastrophe is to work for a state of global economic and demographic "equilibrium." As depicted in this Club of Rome report, only the termination of growth will save man.

Heilbroner feels that population growth, capabilities for warfare, environmental damages, and scientific technology are ushering man down a "descent into hell." Deliverance, he argues, can only come about when "the industrial growth process, so central to the economic and social life of capitalism and Western socialism alike, will be forced to slow down."

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*From the World Future Society Bulletin, July–August, 1976, p. 7–11. Jib Fowles was Chairman, Studies of the Future at the University of Houston at the time this article appeared. Reprinted by permission.

For Ferkiss, "Even if social means are found to avert global war and technological means are found to deal with the complex, interrelated problems of population growth, environmental degradation, and resources depletion, the technology which man has created may still destroy him spiritually and culturally." The answer is to arrest "capitalist, liberal, industrial societies."

There are some signs that these futurists' dire view of humanity's future, and their proposed solution, are getting a hearing in America. To judge from the popularity of these books, the public seems increasingly receptive to the idea of curtailing industrial growth. All three branches of the federal government are now toying with no-growth policies. The Supreme Court has recently permited munticipalities to carry out no-growth plans; the Senate is scrutinizing a Balanced Growth and Economic Planning Act proposed by Senators Humphrey and Javits; at a recent summit meeting held in Puerto Rico, President Gerald Ford was quoted as saying that the Western world would have to rein in economic growth.

It is the contention of this paper that plans and policies which aim at restricting the nation's future economic growth should be strongly resisted. Such planning is unwarranted, I believe, because it is premised on misconceptions regarding economic advance. The problem which no-growthers perceive is in the eye of the beholder. Additionally, there are grave ethical and political issues to do with the implementation of no-growth concepts. It is conceivable that no-growth planning, ostensibly for the salvation of man, actually masks his subjugation.

Thus, the economics, ethics, and politics of the matter all dictate that we should keep hands off the future.

THE ECONOMICS OF IT

The economic growth brought about by industrialization portends man's prospering, not succumbing. In terms of the relationship of *homo sapiens* with the world external to it, industrialization works to vastly increase this species' chance for a safe and secure future. By reducing dependency upon the natural environment, industrial technology permits man to cope better and better with nature's irregularities and assaults. Marauding animals, famines, diseases—they no longer threaten to eliminate humanity. And internally, within the operations of this species, industrialization has generated an ever-increasing abundance which is ever more agreeably distributed.

During the 200-year history of industrialization in the United States, the average citizen has had his occupational duties shift from menial labor to those of a white-collar worker. While 90 percent of the American labor force was tied to the land at the time of the Revolution, only 5 percent are needed in agriculture now; 1956 marks the turning point when the larger proportion of workers were defined as white-collar.[1] With this rise in mean status has come a rise in real income per person, undergoing in constant dollars a remarkable tenfold increase over the past 100 years.[2]

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[1] Daniel Bell, *The Coming of Post-Industrial Society*, New York: Basic Books, 1973, 16.
[2] Gerhard Lenski and Jean Lenski, *Human Societies*, New York: McGraw-Hill, 1974, 317.

Economic wealth does buy health and happiness, no matter what some may claim. The average life span expected at birth is an excellent indicator of the improving state of medical services in industrialized society; over the past 200 years, life expectancy for Americans has tripled. This statistic can never be over-emphasized when the basics of historical change are being considered. Further evidence of the improving well-being of American citizens is revealed in housing trends, which culminate in the post-war years with a reduction of substandard dwellings from 48 percent to 7 percent. Over the same period the high school graduation rate improved by 50 percent, signalling the steadily rising educational levels of the average American.

Sociological surveys announce that higher occupational status, better health, better education, greater affluence—in short, all the attributes of industrialized life—correlate highly with reported "happiness."[3] The more that human beings participate in the bounty of industrialization, the more likely they are to think of themselves as "happy."

Although Americans have enjoyed the benefit of industrialization more than inhabitants of other lands, they are by no means alone in reaching for the satisfactions which it can provide. Polls taken in numerous countries show that virtually all people not only aspire to the amenities of industrial life, but perceive themselves to be in fact edging towards them. Humans the world around recognize industrialization as the agency for a better life; their wish is to participate as soon and as thoroughly as possible. Given these attitudes, it is not surprising to learn through a recent series of rigorous studies that, for the individual in modernizing lands, industrialized life is more likely to bring psychological relief than distress.[4]

With this understanding of the benefits of economic growth, the shortcomings which no-growthers point to would seem tolerable even if they existed to the degree indicated. But closer scrutiny reveals that those shortcomings are not so severe after all. These futurists not only omit the great advantages of industrialization, they also exaggerate the disadvantages.

The consumption of raw materials, for instance, does not augur anything beyond occasional temporary shortages. Man's dependence upon raw materials has proportionally lessened, not increased, because of the gains in knowledge and technology which undergird industrial advance.[5] What industrialization offers is an increasing opportunity for men to take matters into their own hands, and out of the sometimes capricious control of nature.

Mankind is also in little danger of going under because of pollution. The fouling of the environment is a matter very much under human control. It is permitted to occur because the trade-off between the largess of industrialization and the liabilities has so far been perceived as a largely advantageous one. There is nothing new in this arrangement: primitive men did themselves considerable damage by sitting around with their faces in smokey campfires—their most advanced technology—in order to repel insects and beasts, and to enjoy warmth and cooked food. The question is one of striking the optimal balance between the plusses and minuses of the industrialized means of enhancing life. This is a balance which constantly gets readjusted as conditions change; obviously the adjustment process is going on now, heatedly, in advanced societies.

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[3] Norman Bradburn and David Caplowitz, *Reports on Happiness*, Chicago: Aldine, 1965.

[4] Alex Inkeles and David H. Smith, *Becoming Modern*, Cambridge, Massachusetts: Harvard University Press, 1974, 262.

[5] Nathan Rosenberg, *Technology and American Economic Growth*, New York: Harper and Row, 1972, 141.

SIDE EFFECTS CAN BE CONTROLLED

The point to be made here is that the noxious side effects of industrialization can be regulated by men when they so desire, as witness the successful antipollution efforts in the city of London. The human species, like any species, is ultimately devoted to its survival, so there is little chance that it will expire by its own hand. Far short of that point the necessary corrections will be made, and the remarkable ability of the environment to renew itself will be invoked.

In the trade-off for pollution, however, part of what man does receive from the industrial apparatus appears to be of questionable benefit. War machinery has grown steadily more deadly. Nonetheless, there are solid grounds for optimism on this count. To argue that human beings are genetically bellicose is to disregard pre-agricultural human life, where warfare was rarely if ever conducted. Tribes that live solely by hunting and gathering never mass and attack each other. It is altogether possible that in postagricultural society, humans may grow out of warring behavior, in effect reverting to earlier patterns of conduct. If this is the case, the improving of weapons is an obsolete activity, soon to peter out.

The swelling of weaponry has worked to increase popular reluctance about war. This reluctance is part of a change in values, away from a glorification of war, towards a repulsion with it. There is good reason to believe that this shift in values is preceding a shift in realities, and that the probabilities of peaceful coexistence are increasing. Nowadays the best armed are the most reluctant to fight, because they have the most to lose. In pre-industrial times, growth in population often overtook the capability to increase wealth, making conquest attractive; but industrialization has brought about gains in gross national product which greatly exceed gains in population, so war is no longer the road to riches.

Even if humanity does not violently eliminate itself, no-growthers say, the same effect may be accomplished docilely, through crowding. By lowering death rates, industrialization results in a population growth which will cause man to swamp the globe. Yet when seen in perspective, this problem also does not seem so dire.

The term "overpopulation" is a very difficult one to define. As distinguished from rats, men seem able to live comfortably at very high population density, and without any loss of their finer qualities. In the Netherlands, for example, humans lead pleasant and secure lives at many times the density of the United States. The earth can support vastly more people without overtaxing them, or being overtaxed in return. The concept of "overpopulation," then, is a subjective one.

POPULATION GROWTH MAY LEVEL OFF

But even though the world's population tolerances are far more elastic than no-growthers are willing to admit, it is obviously not in man's long-term interest to have his numbers burgeon ceaselessly. There are signs that population growth is beginning to level off, especially in industrialized countries where the birth rate is falling below the replacement level. These countries are completing a demographic transition in which the birth rate drops, following an improvement in the death rate, to eventually bring population into balance. As industrialization spreads, so do these auspicious demographic changes. What some would claim is the cause of the problem is more appropriately seen as the solution.

In this regard, the expansion of industrialization is beneficial. It is also undeniable, as more and more nations climb on the bandwagon. The upshot of this key development is that the gap between the "have" and the "have-nots" is going to close, not widen. A growing number of people can now be characterized among the "haves": the average Japanese worker, who earned only one-sixth the wages of the average American worker in 1955, now earns one-half, while the average German worker has moved from one-fourth to near parity.[6] Taking all the world's nations into account, the disparities in average per capita wealth will unfortunately continue to the year 2000, but after that they show every sign of narrowing.[7] This sharing of the abundance of industrialization is heralded by the fact that the United States has the world's slowest forecasted growth rate for energy consumption—3.5% annually compared to a world average of 5.2%.[8] The spread of industrialization will bring an even-handed distribution of its abundance.

This being the case, the stemming of economic growth can only occur at the expense of developing countries. Their share of the pie would not be able to continue widening. Constraining industrialization would mean hurting the "have-nots" more than anyone else.

If the advantages of industrial growth are as considerable as have been depicted here, and the disadvantages as manageable, then what is to be made of the views of people who are so genuinely concerned and so obviously intelligent as Meadows, Heilbroner, and Ferkiss? How can it be that they and others of their persuasion are so far off the mark? The answer to this has to do with the standards they employ to judge the course of industrialized civilization.

No-growthers appraise developments in terms of ideals and values. Progress can be perceived when looking at historical change; but these futurists are biased by their calling to look ahead to goals, and they are rankled by the shortfalls. Their views are shot through with a dismay which warps their understanding. Thus what they really offer are not truths, but goads. Should these goading reflections be taken seriously and used as the basis of plans and policies, then actual problems may emerge.

RISE OF MASS SOCIETY

To sum up, the changes in the human condition due to economic growth have been, and promise to be, of the most positive sort. As life

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[6] Richard J. Barnet and Ronald E. Muller, *Global Reach: The Power of Multinational Corporations*, New York: Simon and Schuster, 1974, 195.

[7] David M. Freeman, *Technology and Society: Issues in Assessment, Conflict, and Choice*, Chicago: Markham, 1974, 26.

[8] *Joel Darmstadter, et al., Energy in the World Economy: A Statistical Review of Trends in Output, Trade, and Consumption Since 1925*, Baltimore: Johns Hopkins University Press, 1971, 41.

becomes more secure and rewarding, the munificence of industrialization will be more equitably distributed around the world. It will also be more equally distributed within societies. The rise of mass society, as some deprecatingly call this phenomenon, is in reality the extension of greater purchasing power to those segments of society which have traditionally been denied it. Evidence exists that a convergence of income levels is taking place in industrially advanced societies, as the United States.[9]

So humans are being treated to increasingly secure and enriched lives. As a result, they are also growing more kindly and less antagonistic. This decerase in violence may be difficult to perceive when growing opposition to it makes violence seem more conspicuous, but a decrease is the long-term trend nonetheless. Between societies, as has been said, there is good reason to expect less hostility. But more incontestably, within societies people no longer suppress each other as brutally as they did in times past, when slavery was commonplace.

This movement away from violence and towards understanding is most strikingly revealed in changing child-rearing patterns. From the exceedingly abusive practices of 200 years ago, when swaddling and beating were standard treatment, to the present-day indulgence of children, a momentous change has occurred in human sensibility and behavior. The nature of the adults produced by such practices has obviously changed, too. Thanks to industrialization, the slackening of economic constraints is permitting humans to realize their humaneness.

THE ETHICS OF IT

The ethical problems which would be involved in the instigation of no-growth planning are no less troublesome than the economic issues. There are two pertinent dilemmas here. First, what makes the outlooks which underlie proposals to restrain growth superior to other value sets which might generate other sorts of designs for the future? And second, what cognizance is taken of the fact that long-range large-scale planning established in the present may well ride roughshod over the attitudes and wishes of the people who will populate the future? In both instances, no-growth advocates stand accused of parochialism.

It is important to understand that attitudes and values—no matter how sacred they are thought by their possessors—are supremely relative. Not all human beings have subscribed to, or will subscribe to, the same principles. Louis XIV did things which were estimable to his subjects, but repugnant to modern eyes. The American values of 1876 are not identical to those of 1976, and will differ again from those of 2076.

As values are relative in time, they are also relative in space. All people on the face of the earth today do not evaluate matters the same way, or desire the same sort of future. Futurists sometimes ignore the fact that other points of view may have equal claim to shaping what lies ahead. Why shouldn't the attitudes of Ronald Reagan or George Wallace be the basis of planning for the future? Or the president of General Motors?

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[9] Sanford Rose, "The Truth About Income Inequality in the U.S.," *Fortune*, LXXXVI:6, December 1972, 90.

Better yet, given the global impact of what futurists want to do, why shouldn't such plans derive from other notions than those found among Americans? Emperor Hirohito's, for instance? Or perhaps Isabel Peron's, or Ian Smith's? The no-growth advocates, in mistakingly believing that "eternal verities" exist, and that they have a monopoly on them, do a disservice to the rich variety of contemporary viewpoints. Promulgating no-growth values can only be done at the expense of many contending ideologies.

And not only at the expense of present-day ones, but of others yet to come. The issue of temporal imperialism, while little recognized, is altogther real. In the way that 19th century geographical imperialism meant the imposition of one ethos upon its contemporaries, so large-scale planning means the imposition of a current ethos upon future ones. By molding the future, such planning carries out present intentions regardless of those who will have their lives shaped by them. Since values and attitudes change in time, the people of the future may well want what no-growth planners would deny them.

THE POLITICS OF IT

Misconstruing the economics of the matter, and disregarding the ethical ramifications, futurists like Meadows, Heilbroner, and Ferkiss move on to discuss how their ideals should be put into practice. Perhaps unwittingly, there are decidedly sinister overtones to their politics of implementation. It is an oppressive and sometimes vindictive governance which they feel is necessary.

The Limits to Growth, for example, ends with a call for "rapid, radical redressment of the present unbalanced and dangerously deteriorating world situation." This is strong talk, especially for those who are not convinced that the world situation is unbalanced and deteriorating. Who are the redressers going to be, and how will they gain the power to do their redressing? How much suffering and damage will this putative solution bring?

Robert Heilbroner is more explicit: "The passage through the gauntlet ahead may be possible only under governments capable of rallying obedience far more effectively than would be possible in a democratic setting." People who have had experience with such governments know how barbarous they can be. Heilbroner's unnerving sentiments foreshadow a frighteningly repressive rule.

Victor Ferkiss stops short of endorsing a violent breakup of existing structures, but he does hope for some sort of revolution "which seizes the initiative and wrests control of the direction of events." To the new government he would cede whatever power it required to carry out its mission of re-directing society. The task being so immense, the cession of power would undoubtedly be absolute. And so might be the harm done.

While others might say that it is *less* restraint and repression which these times demand, no-growth advocates invite more. Their political schemes are not providential, but foreboding. In the guise of saving man, they are the harbingers of his subjugation. Put most strongly, what they would see instituted is tantamount to totalitarianism.

WHAT IS TO BE DONE?

No-growth planning is to be resisted because it is economically disastrous, ethically suspicious, and politically ominous. Being so out of proportion to the problems, it is the kind of over-reaction which can unhinge things.

Yet there is no denying that the difficulties which the no-growth advocates point out do exist to some degree. They exaggerate but they do not invent. There are indeed things amiss, and there are going to be others. Man will continue to harm his fellow man, covertly and overtly, as he will continue to do damage to nature. Disservices will be rendered, inadvertencies will occur, disarray will haunt humanity.

Having discarded no-growth planning, the question of appropriate response to present and future problems remains. How are the flaws of modern life to be treated? How are the shortcomings to be identified and handled?

The answer is: just as they always have been. The present system, creaky as it may seem at times, has overall been successful in coping with the predicaments of industrialized life. This system is sometimes described as "government by reaction." Largely unanticipated crises appear which may create a furor, but which are presently unresolved. For broad issues, this is the most fitting way.

First, there is far more agreement about crises than there can ever be about such goals as the plateauing of growth. The long-range goals and plans of some can only be instituted at the expense of others, but crises are the property of all.

Second, the responses which get initiated when a crisis is apparent are likely to be generally endorsed, because they are formulated in the public spotlight. If the problem is not one that electrifies the populace, then decisions can be made which may not reflect their widest possible interest. Minus crisis, long-range planning could go on in near secrecy, with the public's present disinterest turning into future dismay.

Rather than establish one smooth path into the future which may be free of surprise but which is certainly not free of coercion, it is better to move forward as democracy would have it—cumbersomely, risking crisis, but without a loss in freedom. As irksome and antiquated as this approach may seem to some, it is to man's long-term advantage, for it means that flexibility and resiliency will be preserved. No-growth planning can make the human enterprise sleeker, but it will also make it more fragile. The less predetermined man's future is, the more adaptable he will prove to be.

Industrialized culture has flourished because, while it has been willing to address present problems, it has not been willing to have its future course prescribed. This openness to the future is the key to its success. If openness to the future can be maintained, there will be no foreclosing mankind's gains.

F. Contrasts in Energy Consumption and Conservation: The United States and Europe

[From U.S. Energy Conservation Could Benefit from Experiences of Other Countries, p. 6–21.]*

CHAPTER 2—ENERGY CONSERVATION MEASURES IN EUROPE

The energy conservation measures of the United Kingdom, Federal Republic of Germany, Sweden, and Denmark did not all come about as a result of the 1973 oil crisis. Many of them, such as progressive vehicle taxes, district heating, and building insulation standards, were already in existence as part of the socioeconomic structure of each country. Some of the measures implemented as a result of the crisis included new building standards, retrofitting of existing buildings, and financial incentives for industry.

The governments of these countries do not have quantitative information on their energy conservation activities because some were not necessarily instituted for conservation reasons and data was not collected to measure energy savings while others have not been in use long enough to be measured and because of the overall difficulties attributing savings to a specific factor. Therefore, we could not quantify the energy savings resulting from most of the specific measures in these countries, but it is generally accepted that the ongoing measures, irrespective of their motivation, have limited or reduced energy consumption.

The measures we examined which appear to have potential for U.S. local, regional, or national application are discussed below and in appendix I.

PRICING POLICIES

The IEA 1976 conservation report stated that the most important elements of energy conservation are prices and taxes. We found that a relatively high rate has traditionally been applied to most forms of energy in the countries we visited. Since 1973, however, even higher taxes have been imposed as a means of reducing energy consumption, especially on retail gasoline. In the spring of 1977, taxes ranged from 49 to 61 percent of the retail price of gasoline in all four countries, compared with about 19 percent for premium grade gasoline in the United States.

	Gasoline	Tax	Percent of tax
Denmark	$1.79	$1.04	58
Germany	1.37	.84	61
United Kingdom	1.17	.57	49
Sweden	1.50	.77	51
Average	1.46	.805	55
United States	.67	.125	19

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*Written and published by the United States General Accounting Office, January 10, 1978, ID 78–4.

The U.S. tax represents total Federal and average State taxes. The President's National Energy Plan includes a request to authorize an additional tax on gasoline if specified annual gasoline consumption targets are not met. This tax would amount to 5 cents a gallon (up to a maximum total of 50 cents) if each year's consumption target was exceeded by at least 1 percent.

In Sweden gasoline taxes are used for rural electrification projects, investments for oil stockpiling facilities, and, more recently, to reduce energy consumption. In Germany most taxes are used for highway construction, with some earmarked for mass transit. The electricity tax in Germany is spent to subsidize coal use in powerplants. The United Kingdom and Denmark energy tax is imposed for general revenue purposes.

PRICING EFFECTS

Although none of the four countries could identify energy savings from higher energy prices, general agreement is that higher prices tend to reduce demand. OECD World Energy Outlook–1977 reported that:

> It has been difficult to identify separately the effect upon energy demand in the past two years produced alternatively by: recession, higher energy prices, milder weather and non-price conservation—although all observers put the likely level of effect on these forces in that descending order.

Most of the officials contacted in the four countries agreed that pricing was crucial in determining whether citizens take conservation seriously. The officials believed that consumers will not independently try to conserve energy unless they perceive it to be to their advantage (i.e., financially foolish not to conserve).

THERMAL EFFICIENCY STANDARDS FOR NEW BUILDINGS

The United Kingdom, Federal Republic of Germany, Sweden, and Denmark had established national thermal efficiency standards for new buildings before the 1973 oil crisis; Danish buildings standards dated back to 1961. Since the oil crisis, these countries have placed increased emphasis on energy conservation and have passed new laws or amended existing laws to increase building efficiency standards to reduce heat loss. Some standards cover only new residences, others include all new buildings.

Although new laws are in various stages of implementation, the mechanisms for enforcing them are already in existence. Local housing authorities in all four countries are responsible for reviewing building plans, approving building permits, and making inspections during and after construction in accordance with national building standards.

Generally, the higher standards will increase building costs and decrease energy consumption, resulting in lower heating bills and eventual cost savings. Examples of energy savings estimated by the governments are as follows:

> The United Kingdom's increased insulation standards for new housing units, effective January 31, 1975, are expected to save 15 percent more energy than standards implemented in 1973.

Sweden's building standards for all construction after July 1, 1977, are expected to increase energy savings by 40 percent over typical buildings constructed in the early 1970s.

Germany's housing standards are expected to save 25 to 35 percent in home heating costs and to reduce energy consumption by 33 percent.

Denmark's increased standards, which become mandatory in February 1979 for all new buildings, are expected to save 39 to 55 percent in energy use for a single family home.

Although we did not attempt to evaluate or verify the basis for these estimated savings, we believe that the measures will accrue substantial savings in energy.

RETROFITTING PROGRAMS

The law increasing thermal efficiency standards for new buildings has left a large area of potential energy conservation untapped—the existing stock of buildings whose construction has covered a wide span of styles, materials, years, and progressively increasing construction standards. To fill this gap, the governments of the four countries have enacted legislation providing financial assistance to encourage energy conservation in existing buildings by retrofitting—improvements to obtain energy efficiency.

The grant and loan programs of Sweden, Denmark, and Germany concentrate on the private sector, while the United Kingdom provides labor assistance for the public housing sector. Denmark also began a program for government buildings in 1975 to improve energy efficiency and to provide employment opportunities.

FINANCIAL INCENTIVES FOR INDUSTRY

The four countries all offer grants, loans, and/or tax allowances to reduce industrial oil use by

adding insulation,
improving heating systems,
using waste or coal in lieu of imported oil for heating,
improving industrial processes,
investing in heat recovery techniques, and
developing prototype and demonstration projects.

The actual energy savings or the success in shifting to readily available fuels could not be identified. However, experience in Denmark and the United Kingdom indicate that incentives must be large enough to be considered economically beneficial by industry.

CONSULTING OR ADVISORY PROGRAMS FOR INDUSTRY

Sweden and the United Kingdom have government sponsored industrial consulting or advisory programs on energy conservation. In the Federal Republic of Germany, nongovernment agencies advise small- and medium-sized firms on energy savings techniques.

Some of the ways in which industry is assisted include:

1-day visits to identify good housekeeping techniques,

followup visits to check on implementation and savings achieved, longer visits (up to 2 weeks) to identify possible technological changes and research and development projects,

an energy manager for each plant, and

courses in a school of fuel management.

PROGRESSIVE VEHICLE TAXES

Germany, Sweden, and Denmark levy progressive taxes on vehicles which make it more expensive to own large or high-powered vehicles. Although actual energy savings and effect of the taxes on the types of cars being purchased could not be clearly identified, the very nature of the taxes make it likely that many people will be motivated to purchase more fuel-efficient automobiles. The type of tax and applicable rate for the three countries are as follows:

Germany has an annual tax of 99 cents per cubic inch of displacement on automobile engine.

Sweden imposes an initial tax on cars of 25 cents a pound up to 3,520 pounds ($880) plus $69.88 for each additional 110 pounds. In addition, the car owner must pay a yearly progressive road tax of $43.61 for gross weight up to 1,980 pounds plus $10.12 for each additional 220 pounds.

Denmark has a weight tax which is paid semiannually—$75.94 for up to 1,320 pounds; $219.38 for 2,861 to 3,300 pounds; and $303.75 for over 4,400 pounds plus $16.88 for each additional 220 pounds.

Annual vehicle taxes imposed by these three governments based on selected weights and engine displacements are shown below.

	Vehicle taxes for—			
	3,520-lb cars		1,980-lb cars	
Engine size in cubic inches	140	300	140	300
Denmark	$607.50	$607.50	$253.12	$153.12
Sweden	114.45	114.45	43.61	43.61
Germany	138.60	297.00	138.60	297.00

There is no U.S. Federal tax based on size of engine or weight of car. However, the President's National Energy Plan proposed an excise tax on less fuel-efficient automobiles and a rebate for new cars which are fuel efficient.

DISTRICT HEATING

Several European countries have found that significant amounts of heat can be supplied to buildings throughout a city by distributing low-grade heat (usually below 212°) from a central heat source via an extensive pipe network using hot water or steam. This process is called district heating.

This process requires a large, dense area of demand for heat, costly investment in pipe networks, and close proximity to a heat source. Therefore, district heating is normally associated with large, densely populated cities where capital investment costs per unit are minimized and can be offset against long-term savings in heat production. The concept and technology of district heating are well established and there is little technical risk in introducing it, but experience sug-

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gests it takes many years to develop or convert a major part of a city to the process.

District heating has fuel flexibility in that a central heating plant can use the fuel (oil, coal, refuse) which is the most economical for the customer. It can also use the otherwise waste heat from existing thermal power, industrial, refuse incineration, or nuclear powerplants.

Cheap waste heat from powerplants near high density areas has influenced the development of European district heating schemes. District heating has flourished in Denmark and Sweden, achieved moderate use in Germany, and is almost nonexistent in the United Kingdom.

REFUSE INCINERATION PLANTS

The original purpose of refuse incineration plants in Europe was to dispose of municipal waste where land was too costly or unavailable for use as dumping areas. Since the early 1970s, the heat output from trash incineration has been harnessed for heat or electrical production for residential and commercial sectors in Europe.

Refuse incinerators will be increasingly considered by European countries as demands grow on land and natural resources. Refuse incineration plants are costly investments and are usually owned by a municipality or a partnership of municipalities. The Federal Republic of Germany is the only one of the four countries which provides tax incentives to build these plants, but municipalities in Sweden and Denmark extensively use them as energy sources.

Sweden has 14 refuse incineration plants providing electricity, or heat and electricity. In Stockholm we visited a plant which started operation in 1970. It was built at a cost of $16 million, operates 24 hours a day, and serves approximately 450,000 people. The 100,000 tons of refuse incineration each year produces the heat equivalent of about 200,000 barrels of oil. The entire operation, from refuse collection to deposit of waste ash, is done at a slight profit. This includes refuse collection fees and revenue from the sale of the electricity generated. The plant is to be enlarged at a cost of $916 million so that by 1979 both heat and electricity can be produced. The steam generated will be sufficient to heat about 10,000 apartments. The incineration of waste will provide 80 percent of the fuel needed to run the plant. It is estimated that this expansion will result in annual savings of about 160,000 barrels of oil at a current value of about $2.2 million.

In Denmark, waste heat from incineration plants has been used for district heating but not electricity production. The plants are owned and operated by the municipalities. Copenhagen built two large plants since conventional disposal of refuse in the vicinity of the city became no longer environmentally sound. We visited one of these plants, built in 1970 at a cost of $20.4 million, which uses heat from refuse incineration for district heating. It draws on a population of 500,000 people and heats 20,000 homes.

CHAPTER 3—U.S. ENERGY CONSERVATION MEASURES AND GOVERNMENT'S ROLE IN ASSESSING FOREIGN MEASURES

Governments must assume the lead in influencing, directing, and legislating the changes necessary for effective energy conservation. In the United States, the executive branch and the Congress have recognized the importance of energy conservation, as demonstrated by administration initiatives, legislation enacted, and the President's energy message of April 1977.

To ascertain whether U.S. energy conservation policies and practices might benefit from the European experience, we contacted executive branch agencies involved in energy conservation activities. We sought information on U.S. agencies' efforts to identify foreign conservation programs in general and, more specifically, the conservation practices identified in our review and the actions they had taken to benefit from the foreign experience. We also identified existing U.S. programs corresponding to the selected foreign energy conservation practices.

U.S. officials generally acknowledged that certain foreign products and practices, including all the measures identified in our review, can be used to consider ways to effect energy savings in the United States. We found, however, that there is little coordinated effort in Government to identify, assess, and distribute information about foreign conservation experiences.

Officials of several agencies agreed that European countries are well ahead of the United States in energy conservation because they have traditionally had high prices on energy whereas the United States has traditionally maintained low prices. Examples of European conservation measures which we compared to U.S. programs and agency comments on them are presented below.

THERMAL EFFICIENCY STANDARDS

No U.S. national standard has been developed applicable to thermal efficiency for new buildings. In an effort to develop such standards, the Energy Conservation and Production Act, amended August 14, 1976, required the Secretary of Housing and Urban Development,[1] after consultation with the Federal Energy Administration and the Department of Commerce, to develop performance standards to achieve the maximum practicable improvements in energy efficiency. The Administrator of General Services is to be consulted only for commercial buildings. These standards would have to be met in order to obtain financing from a federally insured lending institution. The act allows up to 3½ years to develop the standards and 5 years to become effective. President Carter, in his National Energy Plan, directed that the effective date of the mandatory standards be advanced 1 year, from 1981 to 1980. Grants may be made to State and local governments to assist them in meeting the cost of adopting and implementing performance standards. The act authorized appropriations for the grants up to $5 million for the fiscal year ended September 30, 1977, but we were told that these funds were never requested.

A HUD official responsible for developing the standards stated that HUD has not and is not planning to assess European thermal efficiency standards because the U.S. law requires performance standards for the overall use of energy for a building, whereas standards in the four countries visited are based on a maximum heat loss for specific building components (roof, outer walls, floor, windows, etc.).

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[1] The Department of Energy Organization Act, August 4, 1977, transferred this responsibility to the Secretary of Energy.

Officials of several agencies responsible for Federal standards for homes financed under certain Government loan programs and for developing energy-efficient building designs do not consider overall performance standards feasible, at least over the next few years. They noted that Sweden and HUD had tried unsuccessfully to develop and implement such standards. These officials believed it would be more realistic to adopt component standards similar to those used since 1974 to qualify for loans administered by HUD and the Farmers Home Administration. The Farmers Home Administration has recently developed and proposed more stringent standards to (1) reduce energy consumption for homeowners and (2) optimize the cost-effectiveness of additional energy-related improvements. Both the current and proposed standards, like the European standards, are based on allowable heat loss for specific building components.

The agency officials generally believe that the United States could benefit substantially from the experience of the foreign countries. Although they were generally aware that certain foreign countries have thermal efficiency standards for buildings, no objective assessment has been made to ascertain whether the European experience could benefit the United States. European experiences which could benefit the United States include identification of (1) overall application of thermal-efficient technologies, (2) how the various programs were implemented on the national level, (3) adverse effects brought about by such implementation, and (4) how the standards are enforced.

RETROFITTING PROGRAMS

Retrofitting of existing buildings in the United States is done in both private and Federal sectors. The United States has made some progress in promoting energy conservation for houses by providing financial assistance. The Congress has approved several programs in the past few years; however, some of them have been funded at levels substantially less than the Congress authorized. For example, the Energy Conservation and Production Act, authorized:

> FEA up to $55 million in fiscal year 1977 to assist in achieving a prescribed level of insulation in dwellings owned or occupied by low-income persons, but only $27.5 million was appropriated.
>
> HUD up to $200 million to test the feasibility and effectiveness of various forms of financial assistance for encouraging the installation or implementation of approved energy conservation measures in existing dwellings, but no funds were appropriated. The Department of Energy Organization Act, August 4, 1977, transferred this program responsibility from HUD to the Department of Energy.

We could find no evidence that any Federal agency had assessed European retrofitting practices to learn from the experiences and reduce the time required to develop and implement similar programs. FEA officials stated that the European experience could be useful in promoting energy conservation in existing buildings.

CONSULTING AND ADVISORY PROGRAMS FOR INDUSTRY

In 1977 FEA initiated a series of half-day and full-day energy management conferences and workshops throughout the United States to help business and industrial decisionmakers and managers identify the greatest opportunities for energy savings. The program will cost about $3 million.

Although a 1976 review by the International Energy Agency identified consulting and advisory programs for industry in several foreign countries, FEA officials were not aware of them. They said that an assessment of other countries' programs would have been useful in developing the U.S. program and could have reduced the time required for planning and implementation.

DISTRICT HEATING

Several agencies are involved in identifying the use of district heating in foreign countries. Most of their studies, however, do little to assess how foreign technologies and experience can be used to improve U.S. implementation of district heating.

The Energy Research and Development Administration recently initiated a project to identify foreign district heating projects and particularly to assess potential for adopting Swedish standards and programs for the United States. A test project may be started in the Minneapolis-St. Paul area using the experience obtained in Sweden.

An ERDA official stated that using the experience of foreign countries and assessing their potential application for the United States is just being initiated. He added that this approach has been neglected in the past and even now the effort is relatively small in terms of potential benefits.

REFUSE INCINERATION PLANTS

Several agencies have been involved with the operation of refuse incineration plants. Both the Environmental Protection Agency and ERDA have contracted for studies of European waterwall incinerators, a specialized method of solid waste disposal. After potential overlap was recognized, the EPA study was redesigned to complement and expand upon the ERDA study.

The EPA contract, which was let in October 1976 at a cost of $165,000, was justified on the basis that:

> Waterwall incinerator technology in this country is vested in only six facilities built between 1967 and 1976. In Europe, South America and Japan there are several hundred units in operation or under construction. The sophistication with which these systems have been incorporated into the community is impressive. Many are located in the midst of dense residential neighborhoods. Heat recovered from the combustion of waste is used to generate electricity or is used in district heating systems. Some systems involve waste disposal, electricity generation and steam or hot water distribution in what is referred to as a "total energy" system.
>
> Despite this widespread use and acceptance of this type of technology in other parts of the world, the concepts are receiving only mild acceptance here. One of the major problems is that substantive data of the type that an American decision maker or designer would require is just not available. Most information reaching this country amounts to brief plant descriptions presented by the operators of the facilities or the system designers. Problems, if mentioned at all, are not discussed in detail.
>
> A great deal of expertise in the design and operation of such plants which exists in Europe is not being utilized in this Country. Although several European equipment manufacturers are marketing their components in this Country, effective utilization will not occur unless we can learn from the European experience.

The contract, which was to be completed in 1978, is to assess the technical, environmental, and economic effectiveness of European waterwall incinerators and to provide American decisionmakers and designers with the detailed information they need to incorporate the positive aspects of European incinerator design as it has emerged during the past 10 years.

EPA officials believe much more can be done in solid waste disposal. One official stated that an indepth, technical assessment and dissemination of applicable foreign technology advancements would be more useful but that manpower and funding limits preclude such a program. Problems in constructing a municipal refuse incineration plant in Tennessee could have been substantially reduced had such knowledge been available. We were told that erosion and corrosion of boiler tubes will be a recurring problem and that future repairs can cost several hundred thousands of dollars over the life of the plant.

OTHER CONSERVATION MEASURES

U.S. officials agreed that the financial incentives to industry and progressive vehicle taxes used in Europe to conserve energy could be useful in efforts to develop U.S. energy conservation policies and practices. For example, the various financial incentives in the President's National Energy Plan could be evaluated against other countries' policies and practices. Financial incentives for industry could especially be useful to promote energy efficiencies in industry. An FEA official told us that the most frequent comment by about 2,100 chief executives of major companies was that tax incentives promote energy conservation. Also, an FEA-sponsored study in 1975 identified the value of foreign experience in developing programs to provide financial incentives to U.S. industry to invest in energy conservation technology. The publication of the information was delayed, but a report is now expected to be published toward the end of 1977.

ROLE OF FEDERAL GOVERNMENT

A more systematic assessment of foreign energy conservation practices would reduce the time required to develop and implement U.S. conservation programs. The passage of legislation creating a new Department of Energy provides a basis for a more coordinated approach to developing a method for tapping foreign conservation experience. The Department of Energy is to reorganize energy functions within the Federal Government and to develop effective management procedures for a coordinated national energy policy. The stated findings of the Congress in passing the legislation are as follows:

> Responsibility for energy policy, regulation, research, and development is fragmented in many departments and agencies, and thus does not allow for the comprehensive, centralized focus necessary to effectively coordinate energy supply and conservation programs.
>
> Formulation and implementation of a national energy program require the integration of major Federal energy functions into a single department in the executive branch.

Under legislation, an Assistant Secretary will be responsible for international programs and policy. It is too soon to tell what priority will be given to developing information on proven foreign energy-conserving products and practices and disseminating it to Government, industry, and consumers.

We learned of several past proposals made by Federal agencies to use the foreign experience to assist U.S. conservation efforts. These proposals generally lacked high-level agency support, but there are indications that they are now receiving more favorable consideration. Two proposals to assess foreign products and practices for possible adoption by U.S. industry are described below.

Department of Commerce-ERDA international technology-sharing program

A project to share technology internationally was conceived early in 1976 on the general consensus of various Federal agencies that there are indeed many concepts, products, systems, and equipment being used in foreign countries that are more energy efficient than their U.S. counterparts. It was noted at that time that no Government agency appeared to have responsibility for gathering information on foreign energy conservation and disseminating it to the proper parties.

In August 1977 the Department of Commerce, in cooperation with ERDA, formally launched a program to improve the energy efficiency of U.S. industry by informing American businessmen of energy efficient equipment and processes in use or available in foreign countries. The program's feasibility will be tested by a data survey conducted through selected Foreign Service posts. Two approaches are being considered. The first would center on identifying energy-efficient technologies for one or more energy-intensive industries (e.g., glass, aluminum). The second would focus on products and processes available for sale or license to U.S. industries in a specific geographic area and the information would be disseminated through a published periodical. Under either approach, American business will benefit from proven and available energy-efficient items and techniques.

A Commerce official advised us that requests for bids for the surveys will probably go out in December 1977. The contract would be funded by ERDA at a cost of about $100,000.

International technology transfer

In 1975 FEA contracted for a study to review the international technology transfer, as applied to the industrial sector. This included channels of transfer, barriers to and incentives for transfer, and the role the Government might have in promoting the transfer. The plastics, petroleum refining, steel, and cement industries were used as examples of how industrial energy could be conserved through the use of foreign technology and the extent to which energy use was reduced in specific cases.

The draft report with specific recommendations was completed by the contractor in December 1975. We were told that FEA did not support the recommendations and delayed publication of the report. The report noted that, with few exceptions, the United States could benefit by importing foreign energy conservation technology. It stressed the importance of U.S. Government support of foreign technology transfer to help U.S. technology development programs and recommended Government initiatives to identify and assess foreign technology with a view to improving U.S. industrial energy efficiency.

ERDA supported the report findings and recommendations and plans to publish it soon. ERDA officials advised us that they subsequently received FEA support for the report findings and for its publication.

Despite ERDA's extensive involvement with identifying foreign energy-efficient technologies, it was not authorized to develop regulatory or legislative initiatives to implement conservation practices in the United States. FEA has had such responsibilities, including the development and implementation of equitable voluntary and mandatory energy conservation programs, and the efficient use of energy resources. As noted earlier, the creation of the Department of Energy combined these functions as of October 1, 1977.

ROLE OF MUNICIPALITIES

The needs of U.S. cities were emphasized during an FEA-sponsored conference in 1977 of the National League of Cities and the U.S. Conference of Mayors aimed at developing energy conservation guidelines for the cities. In an August 26, 1977 news conference, the mayors of cities pointed out that, although 75 percent of the U.S. population lives in 266 metropolitan areas, the administration has failed to recognize that energy conservation will succeed or fail depending on what happens in the metropolitan areas. They suggested that, through local media and town meetings, the authorities within each metropolitan area could begin to make serious and realistic attempts at energy conservation.

A Swedish study identified systematic municipal energy planning as a way of attaining national energy objectives and proposed legislation imposing this responsibility on the municipalities. The Swedish Government has supported this concept with several energy-related development projects.

CONCLUSIONS

The International Energy Agency's 1976 review of member nations' conservation policies and practices reported that the United States lagged behind in conservation results. Our review identified substantial savings achieved or expected from European conservation measures. U.S. officials generally acknowledged that certain European energy practices and products are more energy effective than those of the United States. However, there is no systematic U.S. Government program to identify, analyze, and distribute foreign conservation experiences that could assist U.S. energy conservation efforts.

The recent initiatives by the Department of Commerce and ERDA in seeking to identify foreign energy-efficient technology and products indicate awareness of the potential in examining foreign conservation advances. However, a comprehensive and coordinated approach is needed to develop information pertinent to U.S. conservation efforts.

The integration of major Federal energy functions into the newly established Department of Energy will permit the comprehensive and central focus necessary to effectively coordinate energy supply and conservation programs.

Federal officials should be mindful of the needs of regional and local governments in developing U.S. conservation efforts.

RECOMMENDATIONS

We recommend that the Secretary of Energy, in consulation with the Secretary of State, evaluate the applicability of proven foreign conservation measures to U.S. energy conservation efforts and consider how best to—

develop a foreign conservation data base,
assess the potential for U.S. use,
identify U.S. users of such information, and
distribute the information as quickly as possible to those concerned.

STUDY EXPLODES U.S. ENERGY-WASTE MYTH*

The high ratio of energy use to gross domestic product (GDP) in the U.S. compared to countries in western Europe and Japan is not necessarily the result of inefficiency or wastefulness in America.

And there are practical limits to the opportunities for changing energy-use patterns in the U.S.—especially in the short term.

This is the central message of a new study on "How Industrial Societies Use Energy," prepared under auspices of Resources for the Future by Joel Darmstadter, Joy Dunkarley and Jack Alterman.

The study is regarded as especially noteworthy in that its findings undermine the strategic underpinning of the Carter National Energy Plan. The structural base for the NEP is that U.S. energy use can be cut without impeding economic growth.

The authors set out to answer the intriguing question: why is per capita consumption of primary energy resources so much higher in the U.S. than in other advanced industrial countries whose per capita income does not differ appreciably from that of the U.S.? Their study took them into a comparative analysis of energy consumption for nine industrial countries.

Why the difference?

They conclude that variations in energy/GDP ratios between countries are bound to endure because of historical or deeply rooted social or geographical reasons rather than because of misguided price signals or misguided energy management.

"The U.S. is not about to acquire the population density of Japan, the geographic compactness of Germany, nor—very likely—the rail network of France, so that in the best of circumstances, some intercountry energy/GDP variability is bound to endure," the authors contend.

"Social customs and conscious individual preferences having different energy-use implications will persist as well. Moreover, energy-saving measures are at least equally likely to be pushed in other countries, so the U.S. will find itself aiming at a moving target," they added.

This doesn't mean there's no chance for energy conservation. "It is unquestionably true that the longer the passage of time, the greater the opportunities for substituting energy-saving processes, equipment, and even lifestyles, for energy-intensive practices and capital," the study said. "In the longer run, what now seems 'structurally' frozen may turn out to be quite flexible."

The study stresses the complex and diverse reasons for intercountry differences in energy consumption and adds that variations should not in themselves be viewed as indicators either of economic efficiency or even of energy efficiency.

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*From the Oil and Gas Journal, Mar. 6, 1978, pp. 30–31. Reprinted by permission.

Energy efficiency

Economic efficiency, the authors said, depends on how energy is used in combination with other resources—particularly capital and labor—and the relative costs of all of these. National energy/output ratios also depend critically on the composition of a country's output and not merely on the energy intensities associated with these component products and activities.

The authors point out that differences in energy usage, such as automotive patterns, appear to be decisively influenced by relative user costs. Other differences, such as suburbanization, housing, and mobility characteristics—each with marked influence on energy use—may owe some of their historic momentum to cheap energy in the U.S. and costly levels abroad.

"Whatever their origins," the study concludes, "some of these features have become such firmly established elements in American society that it would be unrealistic to expect dramatic change or reversal—even in a new energy-price era."

U.S. waste exaggerated

The authors warn that the myth of superior energy-conservation practices in other industrial countries and waste in the U.S. is not supported by facts.

"The need to proceed with energy-conservation strategies appropriate to the U.S. is too urgent a task to allow ourselves to be too much transfixed by a foreign yardstick that, although intermittently revealing, can also be illusory."

The authors' detailed analysis of energy usage in nine countries shows that the U.S. energy/GDP ratio is exceeded only by Canada (Table 2).

The picture for the various sectors:

Industrial

The variations among nations is less for industry. The relative consumption to output ratio in western Europe and Japan is only some 10 percent below that of the U.S. If the energy sector is included, the gap grows to 20 percent, because the U.S. has a large domestic energy-producing industry which itself is a large consumer of energy.

Household and commercial

The variations are greater here with the U.S. ratio about 25 percent higher than other countries.

Transformation losses

Arising principally in production of electricity—are not too vastly different, ranging from 9 to 18 percent of consumption in other countries to 17 percent in the U.S.

Transportation

The greatest differences occur here. The U.S. economy uses 60 percent more energy than European countries and Japan.

Taken overall, the study finds the differences in ratios of energy use and GDP among the nations boils down to this: Transport accounts for about half the difference between the U.S. and other countries excluding Canada. Remainder of the difference is attributed to the household-commercial sector 17 percent; the industrial sector 23 percent; and transformation losses 15 percent.

TABLE 1.—ENERGY CONSUMPTION BY SECTOR, 1972

Consumption by sector	United States	Canada	France	West Germany	Italy	Netherlands	United Kingdom	Sweden	Japan
A. (tons oil equivalent per million dollars GDP):									
Total energy consumption	1,480	1,772	795	1,031	915	1,272	1,121	1,062	849
Transformation losses	250	401	140	170	133	164	254	267	147
Energy sector	135	128	57	74	48	100	81	33	48
Transport sector	327	305	117	132	136	134	145	121	105
Industry sector	309	388	219	299	282	254	318	275	330
Household-commercial	374	480	223	300	220	407	271	348	164
Nonenergy use [1]	86	70	38	55	96	213	53	18	54
All sectors minus transport	1,153	1,467	678	899	779	1,138	976	941	744
B. (index, United States=100):									
Total energy consumption	100	119.7	53.7	69.7	61.8	85.9	75.7	71.8	57.4
Transformation losses	100	160.4	56.0	68.0	53.2	65.6	101.6	106.8	58.8
Energy sector	100	95.6	42.2	54.8	35.6	74.1	60.0	24.4	35.6
Transport sector	100	93.3	35.8	40.4	41.6	41.0	44.3	37.0	32.1
Industry sector	100	125.6	70.9	96.8	91.3	82.2	102.9	89.0	106.8
Household-commercial	100	128.3	59.6	80.2	58.8	108.8	72.5	93.3	43.9
Nonenergy use [1]	100	81.4	44.2	64.0	111.6	247.7	61.6	20.9	62.8
All sectors minus transport	100	127.2	58.8	78.0	67.6	98.7	84.7	81.6	64.5

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[1] Energy raw materials used as feedstock for petrochemical industry.

Source: Resources for the Future report on "How Industrial Societies Use Energy"

TABLE 2.—ENERGY/OUTPUT RELATIONSHIPS, 1972

Country	GDP per capita[1]	Energy consumption per capita (tons oil equivalent)	Energy/GDP ratio[1]	
			Tons oil equivalent per million	Indexes, U.S.=100
United States	$5,643	8.35	$1,480	100
Canada	4,728	8.38	1,772	120
France	4,168	3.31	975	54
West Germany	3,991	4.12	1,031	70
Italy	2,612	2.39	915	62
Netherlands	3,678	4.68	1,272	86
United Kingdom	3,401	3.81	1,121	76
Sweden	5,000	5.31	1,062	72
Japan	3,423	2.90	849	57

[1] GDP is gross domestic product.

Source: Resources for the Future report on "How Industrial Societies Use Energy."

The U.S. picture

Many factors bear on the relatively high energy consumption in the U.S. Among these:

The U.S. is the largest consumer of space-conditioning energy for households and commercial facilities. This arises from larger, single-family homes in the U.S. and from different heating habits.

Transport costs are higher in the U.S. American passenger cars are about 50 percent more energy intensive. Americans travel a lot more than Europeans. And Europeans make greater use of less energy-intensive public transport. Some of these elements are due to higher costs of acquiring and operating cars abroad, greater urban densities abroad, and public transport subsidies. Freight transport factors also differ, with the U.S. reporting a much higher volume of traffic over greater distances.

U.S. industry, which the authors report is proportionately smaller than in other countries, has more energy-intensive production processes.

In interpreting these findings, the authors assert there "is no unique factor which, in quantitative terms, can be singled out as explaining the higher U.S. energy/output ratio."

The explanation, however, lies in several places: The structure of the U.S. transport system, the energy-intensive feature of U.S. industry, the levels of energy prices in the U.S., the sprawling size of the country, the amount of domestic energy resources available, compared to need for imports, and the mix of fuels.

Price impact

The authors observe that prices have a marked impact on level of consumption in transportation and residential sectors but less on industry. They conclude, however, that energy, in common with other things, is used in large volume when cheap and more sparingly when expensive.

Finally, they give the characterization of an energy-intensive economy: A country's energy/GDP ratio will be higher the lower its relative fuel and power prices and costs; the larger its passenger-mile volume relative to GDP; the poorer the fuel economy of its passenger-car fleet; the lower the proportionate role of public transport; the larger its freight-ton-mile volume; the lower the role of rail, pipelines, waterways in freight transport; the larger the size of housing units; the larger the share of single dwelling units; the colder the climate; the greater the proportionate importance of extractive and manufacturing industry; the more energy intensive the industrial sector; the greater the role of electricity; and the greater the degree of energy self-sufficiency.

Although the authors don't recommend any specific program for conserving energy in the U.S., their comparative analysis of the energy picture in the nine industrial countries could serve as important input into conservation thinking.

It tends to explode the myth that the U.S. is an energy waster compared to other countries and points out areas where long-term conservation is a possibility.

PART FOUR

***Resolved:* That the Federal Government should establish a comprehensive program to signifcantly increase the energy independence of the United States**

For the U.S.S.R., the aggressive use of the oil weapon by the producer countries is a priceless asset, providing a peaceful and seemingly innocent means of undermining NATO and indeed the entire Western capitalist system without direct Soviet involvement. For the Kremlin, this must appear a thoroughly enjoyable economic war by proxy. . . .—*Maxwell D. Taylor*

The kind of worldwide energy crisis of concern to the CIA and the Carter administration is unlikely to occur . . . On the other hand, the possibility of a different kind of crisis—a short-term production cutback by the Arab members of OPEC—cannot be ruled out. . . .—*Robert S. Pindyck*

. . . A scenario under which . . . imports will grow only very modestly from 1977 or must be considered a realistic one.—*John H. Lichtblau*

. . . Rapidly rising oil demand may outstrip supply in the non-Communist world as early as 1985, only eight years from now. . . .—*Paul Basile and David Sternlight*

. . . we must choose which kind of social problems we want. The most important, difficult, and neglected questions of energy strategy are not mainly technical or economic but rather social and ethical. They will pose a supreme challenge to the adaptability of democratic institutions and to the vitality of our spiritual life.—*Amory Lovins*

Thus we see the basic paradox of affluence: Enough for everybody turns out to be too much for anybody. If the world were to become steadily more affluent, . . . the natural and cultural environments would be degraded beyond recognition, and worst of all, so would be the people who expect to be enriched. . . .—*Rufus Miles*

This period will not be history's most comfortable one, but it will no doubt be interesting. . . .—*Willis Harman*

A. Alternative Energy Technologies: Prospects and Problems

SOLAR ENERGY

(By J. Glen Moore)*

INTRODUCTION

A basic premise of the Federal energy effort is that some future reliance on new or previously under-used sources of energy will be necessary to help fill the widening gap between U.S. energy demand and supply. In the face of growing concern for the environmental consequences of nuclear and fossil fuel power generation, "clean" sources of energy are sought. Solar radiation, in principle, is such a "clean" source which can help fill the energy gap. Indeed, it is one of the few energy options available with the potential to provide very large amounts of uninterruptible, essentially pollution-free power for the duration of mankind.

The substitution of solar energy for presently used fuels is not without its problems, however. Solar is a diffuse and intermittent power source. Its collection and storage can lead to very high hardware costs. In fact cost has been the principle obstacle to the widespread use of solar conversion technologies. If solar is to make a meaningful contribution to the U.S. energy demand over the next several years, the cost of collection, conversion and storage must be made competitive with fossil and atomic power systems.

SOLAR TECHNOLOGIES

An attractive feature of solar energy is that it is available in a number of forms which can be tapped to provide useful energy in a variety of ways. With hardware that in most cases is technically proven but not now cost competitve with conventional energy sources, solar energy can be converted to electricity or to clean renewable fuels, or it can be collected and used directly for such purposes as the heating and cooling of building space.

Electric power generation.—The conversion of solar energy to electricity is accomplished by four distinct technologies:

Solar thermal conversion—In solar thermal conversion, solar energy is collected as high-temperature heat, generally by means of mirrors or lenses that track the motion of the sun and direct a concentrated solar flux onto a receiver. Temperatures up to 500° C can be generated by this means, high enough to produce steam at pressures for use in modern steam turbines to generate electricity.

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*From Project Interdependence: U.S. and World Energy Outlook Through 1990, A Report prepared by the Congressional Research Service and printed for the use of the House Committee on Interstate and Foreign Commerce, the Senate Energy and Natural Resources Committee, and the Senate Commerce, Science and Transportation Committee, p. 381–388. J. Glenn Moore is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

Photovoltaic conversion—Photovoltaic conversion is a non-thermal process for the production of electricity directly from solar energy. Direct solar radiation is used to create electrical charges in a semiconducting material such as silicon, and the charges are then collected at the surface of the material by metallic contacts. The familiar example of this is the use of solar cells to power satellites.

Wind energy—The winds are caused primarily by the unequal heating of the earth's surface by the sun. Hence, wind energy is a form of solar power. Turbines turned by winds can extract the energy in moving air and generate electricity.

Ocean Thermal Energy Conversion (OTEC)—Between the Tropics of Cancer and Capricorn, where the average intensity of solar energy is at a maximum, 90 perent of the Earth's surface is water. Solar radiation heats this surface water to temperatures of up to 29° C, while water at depths below 600 meters remains cold, typically near freezing at 1.7 to 3.3° C. A heat engine can operate across this small temperature difference, though only at about 2 percent efficiency. The amount of heat in the surface water is so large, however, that even at this efficiency immense amounts of energy are available.

Bioconversion.—Conversion of solar energy into clean renewable fuels starts with the photosynthetic production of organic materials. Solar radiation causes the growth of plants and other organisms such as algae, which can be used after suitable processing (drying, chipping, or grinding) for fuel. Such organic materials can also be converted to methane, hydrogen, or oil by destructive distillation (pyrolysis), fermentation, or by high pressure chemical processing. A resulting fuel such as hydrogen may be used in a fuel cell to produce electricity, or burned directly to produce heat and electricity by standard means.

Direct thermal applications.—The collection and direct use of solar heat is applied to such tasks as the heating and cooling of building space, domestic hot water heating, greenhouse heating and crop drying in agriculture, and the augmentation of process steam generating systems in industrial applications. For most applications of this type, solar energy is captured by "flat plate" collectors. Such collectors do not concentrate sunlight; they consist merely of a black surface directed skyward and covered by one or more transparent covers to prevent loss of heat. Under the right conditions, flat plate collectors easily achieve temperatures of 100° C. Heat is extracted by circulating air or water through channels embedded in the collector's surface. The heat can be used at the time of collection or stored in simple rock bins or water tanks for later use.

Status of technologies.—The various approaches to solar energy conversion can be seen to span a wide range of technologies. Some are very well defined and are now entering the stage commercial feasibility, others require significant research to establish commercial viability. Of the six major approaches only space and water heating systems for buildings, and photovoltaic and wind energy systems for remote electric power applications are considered marginally competitive at this time. Megawatt-capacity wind machines, larger photovoltaic systems and biconversion systems are expected to be available and to become increasingly attractive during the early to mid-1980's. OTEC and solar thermal conversion systems are not expected to demonstrate commercial feasibility before the mid-1980's or later.

Success in any one of the solar technologies will depend on meeting the criteria of technological and economic efficiency, in competition with atomic and fossil fuel power systems.

Paley report.—Perhaps the earliest commentary on the need for solar energy research was provided by the Materials Policy Commission in its report to the President in 1952, the so-called "Paley Report."[1] The Commission recognized that energy plays a key role in meeting the Nation's long-range materials needs. In commenting on the role to be played by technology, the Commission stated that one task should be:

> To develop and use more economically the resources that nature can renew * * *. The direct utilization of solar energy without the necessity for cycling it through stockpiles of fossile fuels millions of years old is perhaps the most important contribution technology can make to the solution of the materials problem.

In its analysis of solar energy, the Commission concluded:

> * * * Efforts made to date to harness solar energy economically are infinitesimal. It is time for aggressive research in the whole field of solar energy—an effort in which the United States could make an immense contribution to the welfare of the free world.

NSF/NASA study.—The Paley report provided no recommendations concerning the content or funding levels for a solar program. In recent years however several solar program plans have been issued which identify levels of funding required for effective research and development. The first, a study prepared by the NSF/NASA panel of experts, was entitled, "Solar Energy as a National Energy Resource."[2] It recommended that a 15-year program be undertaken, at a total cost to Government and the private sector of $3.5 billion. The study concluded that a substantial development program could achieve necessary technical and economic objectives by the year 2020—at which point solar energy could economically provide up to: 35 percent of the total heating and cooling load; 30 percent of the gaseous fuel; 10 percent of the liquid fuel; and 20 percent of the electric energy requirement.

AEC study.—A second major study of solar energy's potential contribution followed the June 1973, Presidential announcement of the initiation of a $10 billion program for energy research and development extending over the next 5 years.[3]

A plan for the implementation of this program was to be developed by the Chairman of the AEC. Background studies for the master plan were undertaken by 16 subpanels working during the month of October 1973. A report on solar energy was prepared by Subpanel IX.[4] This report estimated that 10 to 30 percent of the Nation's projected energy requirements could be provided by solar energy by the year 2000 and as much as 50 percent by the year 2020. An initial 5-year program with two alternative levels of funding was recommended: a "minimum" plan with a budget of $409.9 million and an "accelerated orderly" plan with a budget of $1.056 billion. No attempt was made to develop a maximum or "crash effort" plan. When the overall research and development plan[5] was submitted to the President in December, 1973, the funding recommended for solar energy was $200 million, an amount substantially below the level described as "minimum" by Subpanel IX. This was apparently due in part to the need to constrain all energy funding within the $10 billion specified by the President.

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[1] William S. Paley (Chairman), "Resources for Freedom," a report to the President by the President's Materials Policy Commission, June 1952.

[2] "Solar Energy as a National Energy Resource", prepared by the NSF/NASA Solar Energy Panel, NSF/RANN-73-001, December 1972.

[3] Executive Energy Message by President Richard M. Nixon, The White House, June 29, 1973.

[4] Solar and Other Energy Sources. Subpanel IX, WASH-1281-9. Prepared by the Chairman, U.S. Atomic Energy Commission, in support of her development of a comprehensive Federal energy research and development program to be recommended to the President on December 1, 1973.

FEA study.—Following the announcement of "Project Independence" on November 7, 1973, the FEA issued a series of Project Independence Blueprint reports, including one entitled, "Solar Energy".[6] Two implementation plans for solar energy were developed: business-as-usual and accelerated. While both plans reflect Federal participation in R. & D., only the accelerated program anticipated a Federal role in commercialization. Under the accelerated implementation plan, it was estimated that the combined contribution of the six major solar technologies could reach a maximum of 0.4 percent of the Nation's total energy demand by 1980, 1.2 percent by 1985, 3.4 percent by 1990, and 21.6 percent by 2000. Under the business-as-usual plan, the solar contribution could reach a maximum of 0.1 percent by 1980, 0.7 percent by 1985, 1.8 percent by 1990, and 6.0 percent by 2000. The report cautions however that it would be very optimistic to expect all solar technologies to reach their maximum projected output. Rather, some mix of technologies will probably be implemented, resulting in a lower total annual contribution than would be indicated by the sum totals. The FEA report presented an overall program plan, but lacked complete details on funding requirements.

NSF study.—About 6 months after the release of the FEA report, NSF issued a report entitled, "National Solar Energy Program".[7] It was later established that the budget proposed in the NSF report was consistent with the solar program identified in the FEA Project Independence Report. The 5-year funding levels for the NSF plan are shown below.

RECOMMENDED FEDERAL SOLAR ENERGY RESEARCH AND DEVELOPMENT BUDGETS

[In millions of dollars]

Source	Fiscal year—				
	1975	1976	1977	1978	1979
Subpanel IX:					
Minimum viable program	50.5	67.5	89.7	104.8	97.4
Accelerated program	106.4	188.9	237.2	264.4	259.0
The Nation's energy future	32.5	38.9	41.4	42.2	44.0
National solar energy program	50.0	154.0	242.4	290.0	325.0

ERDA studies.—Program plans have also been prepared by ERDA on the solar energy program and on the total Federal energy research, development and demonstration program. "Definition Report, National Solar Energy Research, Development and Demonstration Program (ERDA–49)"[8] sets forth the National Solar Energy Program as mandated by Public Law 93–473. According to estimates in this report, the future contribution of solar energy could reach 0.8 percent of the total National demand by 1985, 7 percent by 2000 and 25 percent by 2020, assuming that costs can be reduced to the point where solar energy is competitive with other fuel sources.

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[5] "The Nation's Energy Future", a report to Richard M. Nixon, President of the United States, submitted by Dr. Dixy Lee Ray, Chairman, AEC, Dec. 1, 1973.

[6] Solar Energy. Federal Energy Administration Project Independence Blueprint, Final Task Force Report under the direction of the National Science Foundation, November 1974.

[7] National Science Foundation, "National Solar Energy Program," Dec. 1974.

"A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future (ERDA–48)"[9] assesses the relative roles of all energy sources through the year 2000. This report presents six estimates of the possible contribution of solar energy to total U.S. energy requirements, each as part of a potential national energy strategy. The strategy which essentially limits nuclear power production to those plants which are already built or on order resulted in the highest potential contribution of solar energy to National energy needs: 0.6 percent by 1985 and 7 percent by 2000. The first annual update of ERDA–49, designated ERDA 76–1 (April 1976), identifies solar heating and cooling as one of seven high-priority technologies that have the potential for making significant energy contributions in the near to mid-term; solar electric, breeder reactors and fusion were identified as high-priority programs with longer-term potential.

Tabulation of solar impact studies.—For hearings on the small business and Government roles in solar energy,[10] the staff of the Senate Select Committee on Small Business tabulated the wide variety of estimates that had been made of U.S. energy consumption in future years, and of possible solar energy contributions to the National energy demand. The range of estimates of either the combined total solar contribution or the contribution of single solar technologies can be enormous, illustrating the degree of uncertainty involved in any attempt to project the future use of solar energy. The studies are fairly consistent in showing a rather small solar contribution in the near to mid-terms, but vary wildly in estimates of the solar contribution in the year 2000 and beyond.

THE FUTURE UTILIZATION OF SOLAR ENERGY

Uncertainty of estimates.—Solar energy has the potential to make a major contribution to the future U.S. and world demand for solid, liquid and gaseous fuels and electricity. However, the time and extent to which solar-derived power can be substituted for presently-used sources are hotly debated subjects at this time. Future impact will depend on the action and interaction of a complex array of factors including: (1) The cost of energy from non-solar sources; (2) the resolution of certain technical, economic and institutional constraints to commercialization; and (3) the energy policies (including the adoption of incentive measures) established by Federal, State and local governments. Since the outcome of these factors is extremely uncertain, the future impact of solar conversion technologies cannot be predicted with any accuracy.

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[8] ERDA–49. ERDA, Division of Solar Energy, June 1975.
[9] Vols. I and II. ERDA, June 1975.
[10] See appendix.

For most solar technologies there is scant, if any documentation (industry development, sales trends) on which to base a long-range projection. Efforts to estimate even the 5- to 10-year impact are confounded by information gaps which only time can close for certain. Better estimates of future use are dependent on what can be learned from Federal and industry R&D efforts during the next few years, as well as on the timely resolution of anticipated non-technical problems.

Near to mid-term impact estimate.—There seems to be little argument that over the long-term solar will become an increasingly important source of energy. To 1990, however, there is little evidence to indicate that the combined contribution of all solar technologies will amount to more than 2 or 3 percent of the demand (2 or 3 quads). Actually, a contribution of just 1 percent (1 quad) would be a very substantial accomplishment and is probably a more realistic estimate for planning purposes.

Why not more, sooner?—At this time solar technologies are at various stages of commercial readiness. Based on cost and supply trends of presently-used energy sources, and on judgements of R. & D. still required for each solar technology, it appears possible that commercial feasibility can be determined for all solar technologies within the 1990 timeframe. The problem, is however, that even if the marketability of each solar technology is demonstrated on schedule, it is unlikely that rapid commercialization will follow. Instead, acceptance and diffusion of viable solar technologies into the U.S. energy market will probably be slow and may be long postponed.

Market penetration will be slow.—There are several reasons for suggesting that the U.S. energy industry will be slow to substitute solar technologies for presently-used energy systems. First, the industry is too heavily invested in existing systems to convert to solar overnight even if such conversion were possible, which it is not. Consider the difficulty now being experienced with getting utilities to convert their gas and oil-fired plants to coal. Compared to a solar technology, conversion to coal would represent a rather minor changeover.

Second, the huge capital requirement of a mass introduction of a solar technology will most certainly be a limiting factor. Solar powerplants are expected to have a low operating cost, but their initial cost is expected to be several times that of a fossile or nuclear plant. Utilities having trouble raising capital for a conventional plant now may find it impossible to raise three or four or more times that amount for a solar powerplant of equal capacity.

A third reason is a problem that frequently delays the introduction of a new technological innovation, particularly one which must compete with an industry as well established as the U.S. energy industry. Experience with related technology has shown that even after an innovation meets the requisite technical and economical conditions, rapid market penetration is unlikely for at least two reasons: (1) inertia in the spread of knowledge of the innovation's capabilities, plus (2) inertia in the development of a supporting industrial infrastructure for supply, installation, insurance, finance, maintenance, et cetera. This industry lag problem is already a serious one for the solar space and water heating industry. Studies show that this technology is competitive in most parts of the country where the alternative is electric space or water heating. And yet, installations are proceeding at a very modest pace—far short of the pace necessary to produce a meaningful contribution by this technology in the near to mid-term.

Accelerating the solar market.—If solar technologies are allowed to enter the U.S. energy market on a "business-as-usual" basis, there is no reason to expect more than a slow to moderate penetration of the market over the next several years. However, it may be possible to accelerate the diffusion rate with financial and other kinds of incentives. Each of the various solar technologies may require its own set of incentives, but, if effective, such measures could sharply reduce the lag time associated with the introduction of a new technology, and thereby cut the time required for solar to make a meaningful contribution to the U.S. energy demand.

Many types of incentive options are available at the Federal, State and local government levels, each of which could promote a more rapid acceptance of solar technology where such was considered sufficiently beneficial to justify the cost. Several incentive measures are pending in the 95th Congress, including a proposal in the Administration's energy bill which calls for a tax credit on residential and commercial solar space conditioning and hot water installations. If enacted the credit would undoubtedly have an initial positive effect on the market for this particular solar technology.

Disincentives for the continued or expanded use of presently-used energy sources have also been suggested as a means for accelerating the market for solar technologies. Deregulation of the price of natural gas is an example of this kind of solar "incentive."

Another possibility is to use Federal buying power to create an immediate mass market for emerging solar technologies. A problem with solar thus far is that because of high cost, demand has been too low to warrant the use of mass production techniques, but only through mass production will costs be reduced and the systems made practical. The Federal Government could foster mass production by placing very large orders for solar equipment. Again, careful cost/benefit analyses showing substantial gains for the Nation should underlie any such measure.

Numerous other incentive options are being considered. But because so little is known about user acceptance, system performance, and so many other factors, it is yet unclear what the full impact of incentives will be. For example, poor performance by a solar technology in the early stage of marketing could result in a diminished impact; better than expected performance, a greater impact. Incentives can be a valuable tool if properly applied. For maximum effectiveness, the selection and application of an incentive requires precise timing and careful consideration of the interdependent technical, economic, social and political issues involved.

The long-term impact.—Progress in dealing with the technical, economic and social factors should lead to a "coming of age" of solar-electric technologies in the years between 1985 and 2000. But because of the time and capital required to get systems on line, it is unlikely that solar-electric will begin to have an important effect on the energy supply problem until after 1990. The use of solar technology for space and water heating should increase steadily in the near and mid-terms resulting in an important contribution to the U.S. energy demand in the long-term.

CONCLUSION

While no estimate of future impact is conclusive, an estimated solar contribution of 1 percent of the total U.S. demand for energy by 1990 appears to be an attainable number. The largest contribution is expected to come from the technology for solar space conditioning and water heating. Solar-electric technologies are not expected to be commercially feasible before the mid to late-1980's, but may be contributing to the National demand in a small way by 1990. The substitution of solar-electric technologies for conventional ones may not occur on an important scale until well after 1990's due to the large existing investment in conventional systems and the large capital requirements of any solar electric technology. For planning purposes, therefore, it appears that solar-electric technologies might best be regarded a long-range option (important substitution after 1990); solar thermal technology a near to mid-term option on a limited basis, but becoming increasingly attractive over the long term.

OCEAN-GENERATED POWER: OCEAN THERMAL ENERGY CONVERSION

(by John R. Justus)*

In light of the current energy dilemma, researchers in the United States are looking with renewed interests and a sense of urgency at nontraditional, alternate energy sources. In this regard, the oceans could play an increasingly more important role in serving the energy needs of the United States.

In many parts of the world ocean, the temperature differences that exist between warm surface water and cold deep seawater may be as great as 40 degrees Fahrenheit. Temperature differences (gradients) such as these are a potential source of energy—energy, which, unlike that provided by fossil fuels, would be essentially pollution-free and renewable.

The concept of "solar sea power" is not a new one. In 1881, a French physicist, Jacques D'Arsonval, attested to the possibility of extracting energy from the tropical oceans by noting that a heat engine could be built to operate on the temperature differences between surface and deep water.

Schemes for generating power from sea thermal gradients are, for the most part, based upon available technology and envisage either a partially submerged ocean-based platform, or a stationary near-shore platform. The thermal to electrical energy conversion can be accomplished in several ways.

Sea water can be used as a "working fluid" in a method known as the open cycle wherein warm surface water is flash-evaporated under a partial vacuum. This vapor then propels a turbine and is later cooled in a condenser using cold water pumped up from the depths. In 1930, the French engineer, Georges Claude, used this very scheme—that of boiling surface sea water in a vacuum, expanding the vaporized steam through a turbine, and condensing the exhaust steam on cold water. Claude actually produced power at a plant constructed off the coast of Cuba, thus proving the theory to be sound, but the project was an economic failure, because of plant design and technical inferiority of mechanical equipment.

The conversion cycle tentatively preferred by contemporary workers uses a working fluid such as ammonia or propane. In this closed cycle, warm water is drawn from the surface and pumped through heat exchangers where the secondary "working fluid" is vaporized; it then expands tremendously, emerges as a very high pressure vapor, and in this form may be used to drive a turbine. From the turbine, exhaust vapor flows to a condenser where it returns to the liquid phase as it is cooled by water pumped up from depths.

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*Excerpted from CRS Issue Brief of the same title. John Justus is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

A total ocean thermal system operating at sea will probably be contained in a semi-submersible hull incorporating power-pack modules of optimal size. Each would contain heat exchangers, one or more turbines, generators, and pumps to circulate the working fluid and the warm and cold water. The principal applications of OTEC technology are the production of electrical power and energy-intensive products (chemicals, fuels, and metals). Additional applications include the promotion of aquaculture through the supply of nutrients (phosphates and nitrates) contained in the cold ocean water, and the production of fresh water. Studies and proposals by private industries indicate that OTEC power plants in the 100 to 1000 megawatt range have commercial applications for electrical energy transmission to shore and for process applications.

Ocean thermal energy conversion is one of the six solar technologies that constituted the original U.S. solar energy program. Those technologies were selected by the National Science Foundation's Research Applied to National Needs program as being options that could each potentially provide a substantial energy contribution to the Nation. When the U.S. Energy Research and Development Administration (ERDA) was established on January 19, 1975, the lead role in solar energy was transferred from the Foundation to ERDA. This responsibility now resides with the Cabinet-level U.S. Department of Energy (DOE), established by Public Law 95-91 and officially activated October 1, 1977 (Executive Order 12009).

In fiscal year 1977, $13.5 million was appropriated for the OTEC solar electric option in the Department of Energy (DOE). In fiscal year 1978, the Department is operating at appropriation levels of $36.0 million in budget authority (B/A) and $24.85 million in budget outlays (B/O) (see H.R. 7553, Public Law 95-96). Associated authorization levels for fiscal year 1978 were $35.3 million in B/A and $24.5 million in B/O (see S. 1340, Public Law 95-238).

For fiscal year 1979, DOE has requested $32.5 million in B/A and $29.9 million in related B/O. In the Department of Energy authorization bill for fiscal year 1979, H.R. 10969, the House Committee on Science and Technology recommended an authorization level of $61.4 million, up $28.9 million from the requested $32.5 million. The result of this increase in total authorization is an increase in the "Plant and Capital" account of $34.2 million and a decrease in the "Operating Expense" account of $5.3 million.

Currently, ERDA's plans call for ocean testing of 1-megawatt equivalent heat exchanger components in 1979; a 5-megawatt pilot plant (complete power cycle) in 1980-81; and a 100-magawatt demonstration plant in 1983-84. If test results are favorable, commercial OTEC plants could be in operation by around 1990. By that time, industry, utilities, and the maritime community might provide enough capital for constructing commercial OTEC systems to satisfy domestic and international energy demands, although the Government may have to consider subsidizing the first 25 OTEC systems in order to achieve cost reductions.

While proof of concept design studies have been completed using putatively state-of-the-art technology, and although OTEC operating principles are well documented, OTEC systems do pose complex engineering and cost problems. Major investigators point out that refinement, optimization, and further engineering development are needed in several key areas in order to adapt the technology for economically competitive applications. These include: (1) optimization of heat exchangers, from the standpoint of cost and performance, encompassing biofouling, corrosion, and materials compatibility; (2) design of the pipe required for cold water intake; (3) perfection of techniques for positioning of ocean thermal power platforms, e.g. anchoring, mooring, dynamic positioning; (4) biofouling and corrosion of hull and supporting structures; (5) hydrodynamic and structural design of the hull, condenser and evaporator structures; (6) optimization of energy delivery as a function of power plant and market locations, including alternatives for energy storage and transmission; (7) design, testing, and optimization of system components, especially turbines and pumps. Furthermore, at a time when the law governing use of the world ocean is in flux, certain potential environmental, legal, political, and institutional questions need to be addressed before an OTEC power plant could be operated at sea including, but not necessarily limited to: international jurisdictional issues, spatial and emerging use conflicts, regulatory and liability aspects, and financing.

Until operating experience is obtained and economic performance can be verified through large-scale commercial demonstrations of OTEC technology, a certain degree of investment uncertainty will exist. Assuming that the Federal Government does not intend to own and operate OTEC systems directly, the problem becomes one of motivating private and public sector interests to raise the necessary capital and to undertake the construction and operation of OTEC plants. The achievement of this goal will require the engineering of a favorable economic environment as well as the refinement of the technology. In advance of economic competitiveness, a suitable ceonomic environment may have to be created or artificially stimulated. If investment opportunity is not adequate, then a package of stimulating incentives may be required in order to accelerate the introduction of OTEC systems. A 15 percent refundable credit for equipment which converts ocean thermal energy into useable power was considered by the committee of conference meeting to resolve differences over H.R. 5263, the "Energy Production and Conservation Tax Incentive Act of 1977."

FUSION POWER: POTENTIAL ENERGY SOURCE

(by Lani Raleigh)*

Although there are private sector efforts, the primary source of support for the fusion research effort is the Federal Government. The magnetic confinement fusion program, began in 1951, and the inertial confinement program, began in 1962, are managed by the Department of Energy.

NUCLEAR FUSION TECHNOLOGY

Fission versus Fusion

Nuclear fission reactors extract the energy that results from splitting a uranium isotope (U235) into lighter fragments. In contrast, proposed nuclear fusion reactors would utilize the energy released when hydrogen isotopes combine to form a heavier element, helium.

Fission.—In a nuclear reactor, when U235 atoms are struck by neutrons, they split into medium weight atoms, releasing energy and an average of 2½ more neutrons in the process. The extra neutrons produced cause a chain reaction. They collide with other U235 atoms and cause them to fission, thereby releasing more neutrons and causing still more reactions and so on. Energy is released in the form of heat. This heat is then transferred to a coolant. The coolant when heated generates steam which is used to power conventional turbine engines.

Fusion.—Most proposed nuclear fusion power plants are based on the reaction wherein one atom of deuterium and one atom of tritium (both gases, and isotopes of hydrogen) forcefully collide and fuse to form an atom of helium. The reaction releases energetic neutrons which are absorbed by and heat the surrounding coolant. The coolant when heated generates steam, which is used to power conventional turbine engines. The difficulty in achieving nuclear fusion is that such reactions do not begin to occur until the mixture of deuterium and tritium reaches an extremely hot temperature, so that the atomic nuclei are colliding with a sufficient force to overcome their mutual repulsion. At such temperatures, all matter exists in the so-called "plasma" state. The electrons have been stripped from the nuclei, leaving the nuclei (deuterium and tritium ions) and the electrons as two intermixed but separate entities. The different approaches to nuclear fusion may be categorized by the method used to heat and contain the plasma.

Magnetic Confinement

One of the greatest problems in achieving nuclear fusion is confining the plasma and sustaining the reaction long enough to return more energy than invested. For the plasma to remain at the required temperatures, it cannot touch any solid walls or cooler gases. In the traditional design approach, the confinement of plasma is attempted with magnetic fields.

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*Excerpted from CRS Issue Brief of the same title. Lani Raleigh is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

A plasma, composed of charged particles, is affected by a magnetic field. Plasmas will freely slide along in the direction of the magnetic field lines but are inhibited from flowing through the lines. A plasma may thus be held and squeezed in the center of an otherwise evacuated chamber by surrounding it with magnetic fields.

Magnetic Confinement systems fall into two basic categories: open-ended systems and closed, or toroidal, systems. Two typical and well-investigated open-ended approaches are the Theta Pinch and the Mirror Machine.

Theta Pinch.—This early approach attempted to squeeze the plasma into a cylindrical shape. The most serious problem with this approach is the leakage of plasma at the ends of the plasma column. When there is excessive leakage, fusion conditions cannot be reached unless the length of the machine is increased to great proportions.

Mirror Machine.—This problem led to the development of the mirror machine. In this configuration the magnetic field lines close together and intensify toward the ends. Such an arrangement is termed a magnetic mirror because the charged particles moving toward the end, where the field strength is highest, will be reflected back toward the middle. The particles may be reflected back and forth numerous times before they escape. The best known and most investigated closed system is the Tokamak.

Tokamak.—Another attempt to overcome the leakage problem led to the development of the closed, or toroidal, system. This design attempts to improve plasma containment by bending the plasma column into a torus, thus eliminating the ends. The Tokamak (a doughnut-shaped tube, or torus confinement device, development by the Russians) and its derivations are to date the most successful magnetic confinement devices.

Generally, in magnetic containment schemes, fuel would be introduced either continuously or periodically into the reaction chamber where it would be heated and compressed into a dense plasma to produce fusion. The flux of energetic neutrons, which are a product of the reaction, would heat a coolant, such as molten lithium, flowing over the walls of the reaction chamber. The heated lithium would then be passed through a heat exchanger where it would generate steam to power a conventional turbine generator.

Inertial Confinement

Laser Fusion.—Laser Fusion represents an entirely different approach to designing nuclear fusion reactors. The basic concept involves focusing a short burst of high energy laser light onto a minute, frozen pellet of deuterium-tritium (D-T) fuel or a glass microsphere containing a D-T gas mixture. The energy of the laser light, striking and heating the outer layer of the pellet, causes it to explode. This explosion drives the contents of the pellet inward, creating an extremly hot, dense core region where fusion reactions occur. This inward thrust results in inertial confinement of the plasma for sufficient length of time to allow a significant number of fusion reactions to occur.

Particle Beam Fusion.—Instead of a laser beam, an energetic beam of electrons or ions is focused onto the selected target. High energy, high efficiency electron/ion beams offer an economically attractive alternative to high-power lasers. Major research efforts are now directed at creating, transmitting, and focusing the intense beam.

Design proposals for inertial confinement reactors include a large spherical reaction chamber with very strong walls. Pellets would be exploded in the reaction chamber at the rate of about one per second. As in the magnetic containment system, heat would be created in the molten lithium by the capture of reaction neutrons. The heat from the lithium would be used to generate steam to power a conventional turbine generator.

Availability of Fusion Fuel

Ideally, a fusion reactor would operate on a deuterium—deuterium reaction. Since ignition of a D-D reaction is difficult, present first-generation reactor designs are based on a deuterium-tritium reaction. A fusion plants operating on a D-T cycle would be limited by the availability of lithium with which to breed tritium. Some experts have claimed that known and estimated reserves of high quality lithium ores and lithium salts would be sufficient to operate fusion plants for several thousand years.

Recently, however, concern has surfaced over the relatively small rate of current lithium production and the increasing demand for this versatile, light metal. Lithium already has a variety of industrial uses and shows great promise in new types of storage batteries, such as the lithium-water-air and lithium-sulfide batteries, which may be used in electric authomobiles, for local off-peak energy storage in the utility industry, and for intermittent energy sources (solar, wind, etc.). Unless lithium exploration is expanded and supplies are increased, those seeking lithium for use in fusion plants will have to compete with other buyers to obtain the limited supplies.

In addition, lithium ores are currently mined from terrestrial sources. Although it has been suggested that lithium salts can be extracted from seawater, this process will probably remain uneconomical unless new techniques for such oceanic extractions are found.

The supply of deuterium, the other half of the D-T fuel used in fusion plants, is virtually unlimited. A portion of all natural hydrogen is actually the heavier deuterium and is readily separated from water. Thus, if a fusion plant were to operate on a D-D reaction, the world's oceans would be the source of fuel for fusion for many thousands of years.

Environmental Impact

Fusion power generation involves a power minimal hazard from nuclear by-products. Tritium gas has a low energy beta radioactivity and a short half-life (approximately 12.5 years). It is therefore not as hazardous as radioactive plutonium-239, strontium, cesium, or many other fission by-products. However, tritium is difficult to contain, since it diffuses readily through many other materials.

Another environmental consideration involves the reactor vessel itself. Since the neutrons in the D–T reaction are very energetic and will cause the reactor structure to become radioactive after several years of operation, there is a problem of structure disposal or storage.

The fusion fuel cycle involves relatively little handling and shipping of hazardous materials. A small amount of tritium is needed to begin plant operation. Thereafter, the tritium component of the fuel is made within the plant.

Unlike fission plants, a fusion plant would not produce plutonium which is necessary for nuclear weapons manufacture.

Finally, a fusion plant using conventional steam turbines to drive electric generators would have waste heat problems similar to those of conventional power plants. More advanced direct conversion fusion schemes would operate at higher efficiencies and produce less waste heat.

Fusion Economics

The Department of Energy estimates that the total funding requirement for the first complete fusion power plant of commercial size, 500 megawatts electric, is expected to be $15 to $20 billion. However, since there are as yet no final plans for an operating commercial fusion reactor, the economic costs of a fusion plant are at present speculative. New technological developments and quantity manufacturing may result in unforseen cost reductions. Thus, at this point, fusion power costs are impossible to predict accurately. Nevertheless, cost estimates are valuable to the extent that they indicate a general order of magnitude and help to identify particularly sensitive areas for which further cost-reducing development could have a major impact. For example, the ability to minimize radioactivity in the secondary (heat exchange) system would greatly minimize maintenance costs. The development of durable materials will also reduce costs. Such identification of technical problems that may present economic barriers to the implementation of fusion power is useful for directing basic research and for determining the cost feasibility of nuclear fusion vis-a-vis other alternative energy technologies.

State of the Art

Both magnetic confinment and laser fusion reactor designs have a host of theoretical and engineering problems that must be solved before fusion becomes a practical alternate technology. While work continues on efforts to predict plasma behavior, a major problem involves engineering difficulties which prevent testing theoretical hypotheses. Many of these problems require further knowledge of materials. One of the most important of these arises from the unavoidable interactions of components of the hot plasma and its fusion products with the surrounding solid "first wall" of the containment device. Such interactions can result in a variety of mechanical problems such as blistering, sputtering, and embrittlement. Other materials problems involve the development of large superconducting magnets, magnet shields, and system coolants. A problem critical to laser fusion schemes is the development of lasers with durability, high efficiency, high energy, high repetition rate, short wavelength, and short pulse length.

Short-Term and Long-Term Prospects

For technical and economic reasons, even the most optimistic fusion advocates do not foresee fusion as a short-term energy prospect. The Department of Energy predicts that given funding labeled as aggressive in which levels of physics and engineering are expanded to meet programmatic need and new projects are undertaken when scientifically justified, a complete demonstration fusion power plant of commercial size, 500 megawatts electric, could be operation by 1998. . . .

U.S. PROGRAMS

The Department of Engery is supporting fusion research at its major national laboratories—Los Alamos Scientific Laboratory (Los Alamos, N. Mex.), Lawrence Livermore Laboratory (Berkeley, Calif.), Sandia Laboratories (Sandia, N. Mex.), and Oak Ridge National Laboratory (Oak Ridge, Tenn.). Fusion related research is also sponsored at a variety of other Federal labs, universities, and private companies—including the Naval Research Laboratory, Brookhaven National Laboratory, Princeton Plasma Physics Laboratory, Massachusetts Institute of Technology, University of Rochester, University of Wisconsin, General Atomics, KMS Fusion, Inc., and the Electric Power Research Institute.

Significant accomplishments were achieved in magnetic fusion in FY 76. Improved plasma confinement and heating was obtained at several laboratories. The product of plasma density and confinement time was increased 100 percent, to a new world record and to within a factor of 3 of the density confinement time required to demonstrate "break even," where the fusion energy extracted from a system would equal the energy used to create the reaction. And, importantly, many experiments produced data which confirmed the accuracy of theoretical predictions.

Construction began on the Tokamak Fusion Test Reactor (TFTR). The TFTR will be the Nation's first fusion device designed to use deuterium and tritium and will present a significant step in the transition from the theoretical and laboratory studies to the test and development stage of fusion power. The purpose of the reactor is to study the physics of burning plasmas and to gain engineering experience in the design, construction, and operation of a D–T burning Tokamak employing engineering features and systems needed in a experimental power reactor. It will cost approximately $239 million and is scheduled for operation in the early 1980s.

In inertial confinement research, progress was made in the area of driver and pellet technology in both glass and carbon dioxide laser experiments. Fusion ion temperatures and neutron yields are closer to those needed for a fusion reactor, the first significant fuel compression was achieved, and the first neutron yields from electron beam target implosions were observed. . . .

GEOTHERMAL ENERGY

(by John R. Justus)*

The primary use of geothermal resources is for the generation of electricity. Under existing technology, geothermal steam is expanded into a low-pressure turbine, which drives a conventional generator. In some areas, a geothermal reservoir produces natural dry steam that can be brought to the surface and introduced directly into the turbine. Accordingly, the heat of the Earth's core is substituted for the heat created by the burning of fossile or nuclear fuels. In other areas, geothermal water, under pressure of depth and heated beyond the boiling point is brought to the surface where, under the reduced pressure, a portion of the water vaporizes into steam that is used to drive the turbine/generator. In other cases, this hot water may be piped directly through a heat exchanger to boil a secondary "working fluid," which then drives the turbine/generator. Still, a third way of converting geothermal heat into useful energy, where otherwise no steam or hot water is naturally present, is the hot rock method. "Hot rock" is a term for the heated bed rock lying beneath the surface of the Earth at depths ranging from 2,000 to 20,000 feet. Power could be generated from steam produced by injecting water through holes drilled into these hot basement rock formations. A fourth geothermal resource is the geopressured zone. Associated with deep sedimentary basins, geopressured systems are reservoirs of water at very high pressures and temperatures up to 500 F. A valuable feature of the geopressured deposit is the considerable amount of disolved methane contained in the water. This natural gas is recoverable and may provide an additional incentive for exploitation in concert with the hydraulic and thermal energy potential of the reservoir. This resource could be particularly important because its primary occurrence is along the U.S. Gulf Coast, convenient to an area of great energy demand and to gas pipelines serving other regions of the Nation.

Since most promising sites for geothermal development are on Federal or public land, the Secretary of the Interior is authorized to issue leases for the development of geothermal resources on these lands. This authority is granted him in the Geothermal Steam Act of 1970, Public Law 91-581. Also provided for are the size of the lease, its issuance, conversion rights, rents and royalties, duration of the lease, readjustment of lease terms, beneficial uses of water, and ownership of geothermal steam in surface patents.

On December 18, 1973, the Secretary of the Interior announced that competitive lease sales would be held on three known geothermal resources areas (KGRAs) in California. Under the Secretary's actions, competitive bidding took place for the first time on January 22, 1974 for some 50,000 acres in the Clear Lake—Geysers area in North California, the Mono Lake-Long Valley area in Central California, and the East Mesa of the Imperial Valley in Southern California.

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*Excerpted from CRS Issue Brief of the same title. John Justus is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

The Geothermal Steam Act of 1970 did not include any specific recommendations for research and development of geothermal resources; thus, geothermal legislation introduced in the 92d Congress and the 93d Congress tended toward this direction. Continued Congressional interest in geothermal resources, in addition to other environmentally acceptable forms of energy, resulted in the signing of H.R. 14920 into law (Public Law 93–410), the Geothermal Energy Research, Development, and Demonstration Act of 1974. Public Law 93–410 provided for the conduct of research, development, and demonstrations in technologies for the utilization of geothermal resources, and established a loan guaranty program for the financing of geothermal energy developments. . . .

The overall goal of the national effort in geothermal R&D is to achieve by 1985 a 20,000- to 30,000-megawatt commercial electric power-generating capacity, and ensure that substantial increases are made in the commercial utilization of geothermal energy for non-electrical purposes (e.g., industrial processes, space heating, etc.).

In line with these responsibilities, the ERDA program consists of two thrusts: resource utilization technology and supporting R&D. The resource utilization technology program has undertaken R&D efforts involving the following types of geothermal resources: hydrothermal systems, geopressured systems, hot dry rock systems, and normal-gradient geothermal resources. The supporting research and development program incorporates efforts to solve technical problems across the entire spectrum of commercial and industrial activities critical to geothermal development. Areas of emphasis include drilling technology, reservoir engineering and management, geothermal energy extraction, energy conversion systems, thermal waters utilization systems, environmental monitoring and control systems, and cooperative efforts with the USGS in resource exploration and assessment technology.

The Department of Energy's Geothermal Energy Development Program is comprised of six subprograms: (1) engineering research and development; (2) resource exploration and assessment; (3) hydrothermal technology applications; (4) advanced technology applications; (5) utilization experiments; and (6) environmental control and institutional studies.

In fiscal year 1977, $54.7 million was appropriated for the Geothermal Energy Development Program in the Department of Energy (DOE). In fiscal year 1978, the Department is operating at appropriation levels of $116.2 million in budget authority (B/A) and $89.425 million in budget outlays (B/O). The Geothermal Resources Development Fund (loan guaranty program) is continued in fiscal year 1978 at an appropriation level of $15.0 million (see H.R. 7553, Public Law 95–96). Associated authorization levels for fiscal year 1978 were $127.0 million in B/A and $96.075 million in B/O (see S. 1340, Public Law 95–238).

For fiscal year 1979, DOE has requested $137.7 million in B/A and $124.9 million in related B/O. Public Law 93–410 provides for an authorization of up to $50 million per year for the Geothermal Resources Development Fund, so a separate annual authorization is not needed unless the request for appropriation exceeds this figure.

In the Department of Energy authorization bill for fiscal year 1979, H.R. 10969, the House Committee on Science and Technology recommended an authorization level of $160.7 million for the Geothermal program, up $23.0 million from the requested $137.7 million.

OIL SHALE DEVELOPMENT: OUTLOOK, CURRENT ACTIVITIES AND CONSTRAINTS

(By Paul F. Rothberg)[*]

The 1973–1974 oil embargo stimulated renewed interest in the development of new sources of energy. Exploitation of oil from shale could provide a supplemental and secure liquid petroleum and gas source that would, in turn, reduce dependence upon imports from foreign countries and contribute favorably to the U.S. balance of trade. Shale oil production could also yield large quantities of the following byproducts: sulfur, ammonia, alumina, soda ash, petroleum gases, and nahcolite (a material that could be used for stack gas scrubbing).

Two major methods for exploiting oil shale resources are:

(1) Conventional mining (either deep or surface mining), coupled with surface processing of oil shale. Surface processing involves a sequence of three basic steps—mining, chrushing, and retorting (heating) of shale—to produce gas and/or oil. Advanced surface processes include: Paraho, TOSCO–II, Union Oil Company's processes, and Superior Oil Company's process. All these technologies have been tested on a smaller than commercial scale, at either the pilot or demonstration scale.

(2) *In situ* or underground processing of shale. Instead of retorting above ground, shale oil and gas may be produced underground, or *in situ* (in place). Occidental Petroleum Corporation has tested a modified *in situ* technology.

Outlook and Constraints

Production from these technologies could, under current economic and policy conditions, reach 20,000 to 57,000 barrels per day by 1985. This quantity of oil would be insignificant when compared to current U.S. oil requirements of roughly 18 million barrels per day. Even when a commercial oil shale industry emerges, its growth is expected to be slow and gradual.

Over the last 60 years, the emerging oil shale industry has gone through several periods of boom and bust—mostly bust. Since the Arab oil embargo of 1973–1974, industry's plans to commercialize shale projects have generally been delayed or suspended. Progress on all four tracts of the Federal Prototype Oil Shale Leasing Program (discussion follows) was halted for a year because of environmental uncertainties and other problems. To date, commercially related activities have commenced again on the two prototype tracts in Colorado, though companies on the two tracts in Utah are not proceeding with their plans because of legal uncertainties. Superior Oil Company, which has advanced a unique processing technology and owns some shale lands in Colorado, has delayed developing a commercial facility until a land exchange with the Department of the Interior can be consumated. Superior is seeking a better land arrangement for its mining scheme. Colony Development Operation has suspended plans for commercialization on its privately held lands in Colorado.

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[*] Excerpted from CRS Issue Brief of the same title. Paul Rothberg is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

The emerging U.S. oil shale industry confronts many difficulties, uncertainties, and problems. Minimum estimate of construction costs for above-ground retorting (heating of shale to produce oil) have roughly sextupled over the last 6 years, from approximately $250 million to $1.5 billion for a 50,000 barrels per day above-ground facility. The economic feasibility of some processing technologies is uncertain, and commercial scale projects still have to be proven environmentally acceptable and economically feasible. Lester Schramm, of the U.S. Bureau of Mines, suggests that a principal deterrent to above-ground commercial production is the lack of economic incentives. He writes in *Mineral Facts and Problems*, that "the risk/reward relationship portrayed by economic analyses based on estimated costs does not appear favorable enough to attract venture capital in the large amounts needed, unless additional incentives are provided and uncertainties about shale oil's access to free markets are resolved."

The exploitation of oil shale resources threatens to create numerous environmental impacts, such as huge amounts of spent shale, mining waste products, water consumption, water and air effluents, and other land impacts. Many environmentalists are vehemently opposed to development of this resource. Local communities and State governments are particularly sensitive to the social and economic impacts associated with development of energy resources in the West. Companies seeking to operate shale facilities must obtain numerous environmental permits and approvals. Federal, State, and local environmental requirements and standards have constrained and probably will continue to limit efforts to commercialize oil shale technologies.

Uncertainties concerning Federal economic, environmental, and legal policies are also affecting the emerging oil shale industry. Questions include: How will new Federal environmental regulations affect processing operations? Are pre-1920 mining claims on Federal property valid? Will special tax credits for shale oil be allowed? Will price supports be provided for shale oil?

Of the factors discussed above, no single constraint can be identified as the major factor limiting commercialization of the oil shale industry. It is the combination of factors and their synergistic effect, that is likely to keep the contribution of shale oil to the U.S. energy supply at a low level for at least the next 10 years.

Economics of Shale Oil Production

The economics of shale oil production are very uncertain. The cost estimates presented below should be regarded as rough projections. It would appear that about $1.5 to $1.7 billion would have to be invested in a commercial-size oil shale plant producing 50,000 barrels of oil per day above ground. Approximately $425 to $700 million would be required for a plant producing 50,000 barrels of shale oil per day by *in situ* (underground) technology.

The economic feasibility of processing oil shale above ground is judged as marginal at best in today's market conditions. Refined shale oil may require a premium of $5–$10 a barrel over the current price obtained for imported oil.

The economic feasibility of processing shale oil by *in situ*, or underground technology, appears more promising. Occidental Petroleum Corporation recently testified that it could retort (heat), ship to refining centers, and refine shale oil to a full grade of refinery products at prices competitive with OPEC crude. It should be noted, however, that other petroleum industry officials have been skeptical of Occidental's claims. It seems that Occidental is uncertain over the final costs of production and claims that major unknowns such as environmental requirements could change the economic picture by the time production actually starts.

In testimony before the House Appropriations Committee, Dr. Phillip White of ERDA provided the following cost estimates for three types of shale processing systems:

ESTIMATED SHALE OIL PRODUCTION COST

	Investment cost (per daily barrels)	Operating cost (per barrel)	Production cost (per barrel)[1]
Modified in situ	$5,000–$7,000	$3.50–5	$8–11
Surface retorting	14,000–23,000	4.00–5	16–25
Multimineral	7,000– 9,000	2.75–4	9–12

[1] 15 percent DCF, 100 percent equity.

It is important to note that $1 to $4 per barrel should be added to these estimates to produce a quality of oil comparable with Arabian crudes. These cost estimates are in 1976 dollars and thus must be increased substantially for conversion to 1978 dollars. Dr. White noted that:

> Estimates of the costs to produce pumpable feedstock shale oil by modified *in situ*, conventional mining with surface retorting, and by multimineral processing [recovering shale oil, sodium and alumina values in oil shale simultaneously] are listed. Estimates for both the capital cost and operation cost are based on a 50,000-barrels-per-day plant. For comparison purposes, production costs are shown for 100-percent equity and a 15-percent discounted cash flow (DCF).

The range of the estimates indicates the uncertainty associated with differing technologies, different grade shales, and different locations. Recent studies have indicated that combined surface retorting and modified *in situ* processing may result in significant cost reductions and at the same time increase resource recovery.

Budget Authority Request

The budget authority request from the Department of Energy's oil shale program is estimated at $29,350,000 for fiscal year 1979. The Federal research and development program focuses on *in situ* processing and the environmental impacts of shale development.

Resource Base

The western U.S. (Colorado, Utah, and Wyoming) oil shale higher grade resources contain the equivalent of about 600 billion barrels of oil—roughly equal to the known world reserves of oil. If the lower grade resources are added, the resource base of the western shales is about 2 trillion barrels of oil—more than 50 times the total U.S. reserves of petroleum. Competitive *in situ* (underground) and deep mining technologies may make possible the recovery of a much larger portion of the 2 trillion barrels of western shale oil resources, which include low- and medium-grade shales. The Federal Government is by far the major owner of western shale oil resources.

"Eastern" or "Central" gas shales have been located in Ohio, West Virginia, Pennsylvania, New York, Kentucky, Michigan, Indiana, Illinois, Virginia, Tennessee, Mississippi, and Alabama. Columbia Gas System Supply Co. estimates that about 285 trillion cu. ft. of producible gas lies beneath Ohio, West Virginia, Pennsylvania, Kentucky, and New York. Increased funds for R&D on eastern shales may allow expanded work on chemical characteristics of oil shale and shale oil, *in situ* processing, and basic support work. The U.S. Geological Survey, Department of the Interior, has initiated on behalf of DOE a 5-year program to assess the gas potential of black shales of Devonian age that underlie an area of more than 160,000 sq. mi. in the Appalachian basin. The processing of Eastern oil shales is being researched under a contract by Dow Chemical Company and the Michigan Energy Resources Research Association.

The Secretary of the Interior has the responsibility for leasing and managing the publicly owned oil shale lands. Leasing policies for these deposits have an important bearing on the rate of development of this resource, because 72 percent of the U.S. shale lands, containing nearly 80 percent of the total quantity of shale oil, is federally owned.

Major Activities

Until recently, the federally owned oil shale deposits were not available for private exploitation. During the early 1970s, the Department of the Interior established the Federal Prototype Oil Shale Leasing Program, which was intended to provide a quantitative evaluation of environmental impacts, as well as prove several technologies, and provide firm cost and economic data. Six tracts of land (two each in Colorado, Utah and Wyoming) were offered for lease. The highest bids accepted were $210 million for tract C-a in Colorado, $117 million for tract C-b in Colorado, $75 million for tract U-a in Utah and $45 million for tract U-b in Utah. No bids from industry were received on the two oil shale tracts offered for lease in Wyoming. Preparation of detailed development plans and collection of environmental baseline data have been major activities on Colorado tracts C-a and C-b, and on tracts U-a and U-b in Utah. The following paragraphs described briefly *some* of the activities on these tracts.

On Colorado tract C-a, the Rio Blanco Oil Shale Project has collected extensive geotechnical and environmental data to establish baseline conditions on and around the tract. These studies also provide input to engineering analysis which will be useful in the selection of mining and processing plans for development. Investigations have included work on mining, engineering, hydrology, geology, community planning, soils, overburden, and revegetation. The Department of the Interior has approved Rio Blanco's plans to begin development of tract C-a by the modified *in situ* processing. The plan projects to intermittent production of shale oil at about a 1,500-barrel-per-day production level. Some shale oil is expected to be recovered by above-ground processing. These companies plan to spend $93 million for 5-year developmental programs.

At Colorado tract C-b, investigations have been conducted on surface water, core drilling and associated ground water, air quality, fish and wildlife management, revegetation archeological studies, and scenic values related to tract C-b. These studies have been reviewed by the Oil Shale Environmental Advisory Panel of the Department of the Interior, which examines aspects of the Federal Prototype Oil Shale Leasing Program. A detailed development plan on tract C-b has been submitted and approved by the Department of the Interior. This tract is expected to be developed using a modified *in situ*, technology advanced by Occidental Petroleum Corporation. Ashland Oil and Occidental Petroleum Corporation now hold the lease to tract C-b. These companies plan to spend $440 million to develop a plant capable of producing 57,000 barrels per day by 1983. The costs of the shale oil produced from this plant may be competitive with world oil prices.

Planning for the development of tracts U-a and U-b is being done on a cooperative basis. The three companies involved in these tracts, Phillips Petroleum Company, Sun Oil Company, and Sohio Petroleum expect that the U-a and U-b project, called the White River Shale Project, will become a three-company equal ownership situation. The project is located in Uinta County, about 40 miles south of Vernal, Utah. Full-scale production on the tract may be between 50,000 and 100,000 barrels/day. Reports summarizing environmental baseline data collection and monitoring programs (including water, air, biological resources, geology and soils, historic and scientific resources, revegetative studies, geologic exploration, and aesthetics) on combined tracts U-a and U-b have been reviewed by the Oil Shale Environmental Advisory Panel.

The White River Shale Project has postponed its commercial plans, partly because of clouded title to the land and uncertainties as to the future of air pollution standards in Utah.

The Federal Coal Leasing Amendments Act of 1975, passed by the 94th Congress, may aid States in reducing the social and economic impacts of oil shale development. This law (Public Law 94–377) amends the Mineral Lands Leasing Act, as amended, by requiring an additional 12½ percent of all moneys received from sales, bonuses, royalties, and rentals of public lands under the provisions of the Act and the Geothermal Steam Act of 1970 to be paid by the Secretary of the Treasury to the State within the boundaries of which the leased lands or deposits are or were located. This additional 12½ percent of all moneys paid to the State on or after January 1, 1976, shall be used by such State as its legislature directs. The law also allows that certain funds received from Department of the Interior oil shale test leases shall be used by the States of Utah and Colorado as their legislatures direct, giving priority to those subdivisions socially or economically impacted by the development of minerals leased under the Act.

The 94th Congress also considered a number of bills that would have provided loan guarantees for demonstration programs to produce synthetic fuels from coal, oil shale, and other domestic resources. After a series of intensive hearings lasting throughout most of the 94th Congress, this legislation (H.R. 12112 and similar proposals) was not approved by the House.

In the 95th Congress, the House and the Senate debated economic means to stimulate the demonstration of synthetic fuel technologies. With the enactment of Public Law 95–238, which authorized appropriations for the Department of Energy, Congress provided a loan guarantee provision for producing alternative fuels from coal, oil shale, biomass, and other domestic resources. Under the provision, the Secretary of Energy will be authorized to guarantee loans to companies seeking to demonstrate technology for tapping alternative fossil energy sources. With the government pledging payment of these guarantees, this new initiative may remove some of the financial constraints on the demonstration of coal liquefaction and gasification, biomass, and oil shale facilities. Demonstration facilities may yield important information concerning the technological, economic, and environmental costs and benefits of synthetic fuels.

President Carter's recently announced National Energy Plan includes one recommendation for development of the vast U.S. oil shales:

> The Government should establish a pricing policy that provides adequate incentives to producers. Accordingly, shale oil will be entitled to the world price of oil.

Since the Federal Energy Administration determined in 1976 that shale oil was to be unregulated oil, the President's recommendation is expected to have little, if any, effect on current Federal policies influencing investment in commercial shale ventures. In view of the President's well-known concern for the environment and conservation, it is not surprising that he assigned oil shale development a minimal role in his National Energy Plan—Part I.

Options for Future Shale Oil Development

In view of the technical, economic, and environmental constraints now facing an oil shale industry, it appears that without major new legislative initiatives or administrative actions, there will be no commercial plans processing shale above ground between now and 1985, and possibly not even until 1990. If existing leasing policies continue, the processing of shale underground using *in situ* technology may be confined to a few tracts of land.

A mix of congressional and executive actions would seem to be required to stimulate the growth of a competitive shale oil industry. Options include:

(a) *Modular approach.*—Through appropriate legislation, the Congress could support the construction of a series of modular oil shale units to test a variety of retorting processes. Each modular unit could be used to develop technology (at the 10,000 barrels per day stage), and at that level, could provide a basis for predicting capital, economic, and environmental costs for an expanded commercial facility.

(b) *TVA or COMSAT approach.*—In the 95th Congress consideration could be given to the establishment of a corporation, similar to TVA or COMSAT, to develop oil shale. The House Interior and Insular Affairs Committee held hearings during the 93d Congress on the "Oil Shale Mining and Energy Corporation Act" (H.R. 12014), which would have established a public corporation to explore and develop all oil shale energy resources on Federal lands. This corporation would have used non-nuclear *in situ* or underground retorting technology as the preferred means to extract oil from the federally owned shale resources.

(c) *Low/medium/high level approach.*—The Synfuels Interagency Task Force, established as a part of the Synfuels Commercialization Program, set forth low, medium, and high shale oil production levels that might be reached with various government incentives. At the low-production target level (150,000 barrels per day), legislation would be required to provide appropriations authority for government-industry cooperative efforts to develop commercial scale prototype technology. At the medium-production target level (280,000 barrels per day), appropriations and tax legislation would be required for the implementation of economic incentives needed to stimulate production. Legislation probably would be required to permit off-site plan location and spent shale disposal. To relieve socio-economic impacts in the oil shale regions, the Congress could have to provide additional financial assistance. At the high-production target level (830,000 barrels per day), additional legislation would probably be required to permit near-term development of supplemental water imoundment capacity, to modify existing air and water quality standards or other environmental regulations, and to provide priorities to energy-producing industries in procurement of necessary construction or machinery.

(d) *Research and development approach.*—In conjunction with any of the above mentioned approaches, the research and development activities pertaining to oil shale of the Department of the Interior, the Environmental Protection Agency, and the Department of Energy could be accelerated.

However, because of the known and unknown consequences of oil shale development, congressional actions seeking to stimulate the shale industry may have to be balanced by cautious concern for the environmental integrity of the lands involved, the social and economic impacts caused by commercialization, and the economic stability and costs to the Nation and to the affected States. Careful oversight and control of the emerging industry could be coupled with any provision to stimulate its growth. Vigorous efforts to meet and enforce reasonable environmental and regulatory practices may prove to be compatible with a competitive oil shale industry.

There is, finally, the option of allowing current Federal policies concerning oil shale development to continue as they are. With this course of action, it is likely that the environmental and social costs resulting from oil shale development would be minimal. However, the long term impacts on the Nation's economy and security could be enormous, especially if the United States had to face a major petroleum embargo without the assistance of a synthetic fuels (oil shale and coal) industry.

COAL GASIFICATION AND LIQUEFACTION

(By Paul F. Rothberg)[*]

COAL GASIFICATION

In the coal gasification process, coal is converted to synthetic gas. Three kinds of such gas are currently being considered for commercial development: high Btu, referred to as substitute natural gas (SNG), which has a heating value of about 1,000 Btu/cu.ft., medium or intermediate Btu, which has a heating value of 300 to 400 Btu, and low Btu, which has a heating value of about 150 Btu/cu.ft. SNG has almost the same chemical and physical properties as natural gas, and they are completely interchangeable.

Substitute natural gas from coal could be used in the Nation's existing gas system, thus reducing shortages in the residential market. Low- and medium-Btu gases are industrial fuels and would be used at or near the site of production. These gases may also be used in gas turbines or combined cycle plants for the generation of electricity.

Gasification Based Upon Existing Technology

When coal is gasified, it is reacted with steam and/or hydrogen at temperatures greater than 1000 degrees F to form low-Btu gas, which is composed primarily of carbon monoxide and hydrogen. To produce SNG, which has a high heating value, the product gas may be cleansed of impurities, and then upgraded to the quality of natural gas. During this process, undesirable components in coal, such as sulfur, are converted into forms that can be readily removed. Gasification also removes ash.

Technology for gasifying coal has been successfully demonstrated in several foreign countries. In U.S. markets, the price of the synthetic gas produced by these processes would probably be much higher than that for conventional fuels.

Gasification Based Upon Advanced Technology

Primarily over the last 15 years, the Federal Government and industry have advanced and tested new technologies to convert coal to useful energy products. Several pilot plants that can produce synthetic gas are in operation, under construction, or have been completed. These technologies are based on modified versions of older technology originally used in Europe or on new technology developed in the United States. The Department of Energy (DOE) divides its R&D coal program into several areas including high-Btu and low-Btu coal gas. DOE's estimated budget authority for coal gasification for fiscal year 1978 is $141.6 million.

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[*] Excerpted from CRS Issue Brief of the same title. Paul Rothberg is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

High Btu Coal Gas.—The DOE program includes several major second-generation pilot projects designed to develop an improved process to manufacture substitute natural gas (SNG). Included in the Department's program is the HYGAS process, developed by the Institute of Gas Technology; the CO_2 Acceptor Coal-Gasification process, developed by the Consolidation Coal Company; the Synthane process, developed by the U.S. Bureau of Mines; and the Bi-Gas process, developed by Bituminous Coal Research, Inc. Many of these projects are funded jointly by the American Gas Association and the Department of Energy (DOE). The Association typically provides one-third of the funding, with the Government providing the rest. The processes under investigation differ substantially from each other. The process, or combination of processes, most feasible for commercial application still must be determined.

The HYGAS process, in which coal reacts directly with hydrogen-rich gases to produce methane, began pilot-plant operation in 1971. In 1974, its steam oxygen process for generation of hydrogen came on-stream. In May 1975, it ran under self-sustaining conditions and by the end of June it completed experimental runs on lignite. Continuing into 1977, the pilot plant will use bituminous and sub-bituminous coals as feedstock. This will provide a data base for scaling up the process for demonstration or commercial purposes.

The CO_2 (carbon dioxide) acceptor pilot plant has been completed. A series of runs appears to have fully demonstrated the technological feasibility of the processes. Most of the major mechanical problems also appear to have been solved.

The Synthane plant emphasizes the production of more methane directly in the gasifier, thus reducing the load in the methanation step. Mechanical construction was completed in June 1975. Currently, the pilot plant is processing agglomerated bituminous coal. Operation with this coal will continue into fiscal year 1979.

Construction of the Bi-Gas plant in Homer City, Pa., was completed in September 1975. Pilot plant research will run through fiscal year 1979, at which time a decision will be made on future development.

Technologies advanced in this program may, over the long-term, reduce the cost of producing synthetic gas for residential purposes. The program is expected by many to continue until industry can construct, with an acceptable degree of risk, a commercial-size plant based on one or a combination of these processes. The next stage in this program would be the construction and operation of demonstration-sized facilities.

Low-Btu Coal Gas.—The generation of low-Btu gas from coal requires a less complex plant than that required for production of high-Btu gas. Consequently, capital and operating costs are expected to be lower per unit of energy. Low-Btu gas systems are much closer to being commercialized than high-Btu plants. Within the next few years, small sized low-Btu gasifiers based on existing technology may be installed at several sites, including a tractor factory in York, Pa.; a steam boiler at the University of Minnesota's Duluth campus; a Pittsburg, Pa., plant to heat kilns and dryers; and at a housing project in Lexington, Ky. According to Roger Broeker of Foster Wheeler Corp., these units are said to be competitive with burning oil and gas.

To advance the current state of technology, DOE is funding several promising new concepts for low-Btu gas generation. Laboratory and pilot plant projects include: fluidized, entrained and fixed-bed gasification systems; molten salt pressurized process; and ash agglomeration. Several projects will be completed by fiscal year 1979; however, some are expected to run beyond fiscal year 1981.

Outlook for a Coal Gasification Industry

The American Gas Association has recently published a status report on planned commercial and demonstration high-Btu coal gasification projects. This report indicates that many of the interested companies have suspended their projects, have not yet filed with the Federal Power Commission (FPC), have requested deferral of FPC decisions, or have conducted only preliminary feasibility studies. Even though these companies previously expressed serious intentions to operate commercial-sized facilities, construction of the first large scale plant in the United States has not yet begun. Mere interest in commercialization is many steps away from the corporate decision to invest the estimated $1.6 billion to $1.7 billion required for a plant to produce large quantities of gas, such as 250 million cubic feet per day, for residential purposes.

Efforts to commercialize large-scale coal gas plants in the United States have confronted an array of obstacles, including: high capital requirements and uncertainties of regulatory policy. The industry hopes for a supportive Federal synthetic fuels policy. The future of a synfuels industry will depend on several factors, such as its ability to compete in the market place; availability of water, materials, and manpower; willingness of financial institutions to lend the billions of dollars required, and Federal policies affecting this industry.

According to the Synfuels Interagency Task Force, which was used by the Ford Administration to design a program to commercialize synfuels, the outlook for both high-, medium- and low-Btu gas plants is limited under existing policy and economic conditions. The task force maintained that the overriding constraint facing this industry was short supply of venture capital. They argued that until there was a positive growth-oriented industrial and financial environment, only limited funds would be spent on future planning by industry. They concluded that significant production of low- or medium-Btu gas from coal in the 1975–1985 time period was unlikely. (The exception to this will be the very small low-Btu gasifiers discussed above.)

With respect to high-Btu gas plants, the task force maintaned that, "given the current regulatory climate together with the enormous increases in required investment and the resulting prices . . . [that] in the absence of new Federal initiatives, no commercial development will take place in time for significant production by 1985."

It appears unlikely that commercial plants will be producing as much as 250 million cu. ft. of pipeline quality gas per day before 1985. If existing conditions impacting on synfuels production and marketing are not altered, there may be no commercial (large-scale) production of coal-based high-Btu gas by the early 1990s. However, should a favorable climate develop for synfuels production, e.g., Federal loan guarantees, favorable pricing, environmental, and regulatory policies, and available water and construction materials, a slow but gradual growth of a coal gasification industry may be possible.

COAL LIQUEFACTION

Coal liquefaction is the process of converting coal to synthetic liquid products, such as boiler fuels or petrochemical feedstocks. During World War II, the Germans used this technology to supply a large portion of their liquid fuel needs. Industry and Government are now developing modern liquefaction processes. DOE supports pilot plant and laboratory projects to advance three liquefaction processes: solvent extraction, direct hydrogenation, and pyrolysis. These projects are the initial stage in a program leading towards commercialization of new coal liquefaction technology. DOE's estimated budget authority for fiscal year 1978 is $110.2 million.

Demonstration Plants and Commercial Plans

Coal liquefaction is gradually moving from the pilot plant to the demonstration plant, the second major stage in DOE's effort to advance this technology. ERDA's Fossil Energy Program sought competitive bids to bring its demonstration program to a successful conclusion over an 8-year period. In a comprehensive request-for-proposal to industrial firms and others, the Fossile Energy Program asked for details for a plan to design, construct, and operate a demonstration plant for converting high-sulfur coal into a clean liquid boiler fuel. Subsequently, in January 1975, a $237.2 million contract was awarded to Coalcon Co. of New York, an affiliate of Union Carbide and Chemico, for a coal-to-clean-boiler fuels demonstration plant. Using 2,600 tons of coal per day, the plant was expected to produce 8,990 barrels of liquid and 22 million cu. ft. of synthetic natural gas each day.

Coalcon formed a consortium of private companies and public agencies to support the program. The plant was to be built in New Athens, Ill. The process used was to be a combined hydrogenation and pyrolysis method that produces gases, liquids, and solids. The solids are used for process heat and for producing additional gas. According to a GAO report, the project was plagued by technical and managerial problems from the onset; it failed in its initial phase despite, a $10-million cost overrun and a 14½ month schedule slippage. The project was terminated on June 15, 1977. The Department of Energy has selected the Solvent Refined Coal (SRC) process for advancement in a new demonstration project. For fiscal year 1979, DOE has requested $3 million in operating expenses and $20 million for capital acquisition for this project. Under existing market conditions and Federal policies, it is unlikely that any company would build a commercial-size liquefaction plant within the next five years.

Without Government incentives, commercial production of synthetic liquids from coal is projected to be zero through 1985, and possibly until 1990 or beyond. First generation technologies would produce products only at price levels well above those expected to represent future world price levels for oil.

Concerns Associated with Development of a Synthetic Fuels Industry

The development of large-scale synfuel plants could result in the following technical, environmental, and regulatory problems.

Technical Concerns

The size envisioned for a commercial synfuels plant in the United States is enormous. Industry commonly talks about commercial plants producing from coal 50,000 barrels of liquid fuel or 250 million cu. ft. of gas per day, or some combination thereof. Worldwide experience in building synfuel complexes is rather limited. Construction of the huge plants envisioned in the United States could result in many technical uncertainties and material shortages.

With respect to coal liquefaction, many would argue that second generation direct liquefaction technology is not ready for commercialization. Considerable development and demonstration work remains to be done on advanced liquefaction technology.

Socioeconomic and Environmental Concerns

Many environmental problems associated with synfuel technologies are common to other processes that require coal. Among these are health and safety aspects of coal mining, reclamation of strip-mined lands, allocation of scarce water resources (especially in the West), and pollutants and particulates emitted to the environment. Compared with a conventional coal-fired power generating system, a coal gas plant is expected to consume less water and to emit less air emissions into the environment; that is, a coal gas plant is expected to emit less particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons.

A synthetic fuel industry in the West may have an impact on small and relatively poor towns or Indian reservations. During construction of this industry, it is feared that "boom towns" would be created. Under such conditions, local service institutions would not be able to handle increased populations associated with synfuel projects. Care and planning would facilitate reduction of the adverse effects of boom/bust cycles. The Congress has already taken some action to reduce the social and economic impacts of coal developments. In the Federal Coal Leasing Amendment Act of 1975 (Public Law 94–377), the Mineral Lands Leasing Act was amended so that an additional 12½ percent of all moneys received from sales, bonuses, royalties, and rentals of certain public lands (including Federal coal and oil shale deposits) shall be returned to the State within the boundaries of which the leased lands or deposits are located.

Financial and Economic Concerns

High Btu synthetic gas from coal may cost about $3.00 to $4.50 per thousand cu. ft., which would be uncompetitive with new, interstate gas that sells for about $1.45 per thousand cu. ft., under current Federal regulation. Oil from coal will probably cost more than $20 per barrel, which would be uncompetitive with the current world price of about $13–$14 per barrel. Some forecasts predict that the prices of the synthetic fuels will become competitive around 1990. Before that time, the partisans of accelerated development of synthetic fuels must deal with a financial community that is dubious about financing an industry whose product is unlikely to be competitive. Many advocates of synfuels development argue for Federal economic incentives to stimulate commercialization. A spokesman for the Institute of Gas Technology (IGT) recently estimated that a commercial-size coal gas facility (one producing 250 million cubic feet of high-Btu gas per day) would cost $1.6–$1.7 billion. The following table shows IGT's 1977 cost estimates for various forms of energy products produced from coal.

Energy product	Cost per million Btu's	Efficiency (percent)
High-Btu gas	$3.00-$4.50	65-70
Solvent refined coal	2.50- 3.50	70-80
Low-Btu gas	2.50- 3.50	70-80

Firms interested in substitute natural gas have complicated finances since they are usually regulated utilities. Compared to the major oil firms, their capitalizations are small, about $1 billion, and their indebtedness is limited to a certain percentage of their assets. Thus, in order to commercialize coal gas plants, advocates note that consortiums may have to be formed and maintained in the face of much uncertainty.

The financial community is also concerned that a huge amount of capital must be formed and devoted to the energy market as a whole if the country's energy goals are to be met. It is generally agreed that the economy can generate enough capital, but it is not clear that devoting a large portion of this capital to developing synthetic fuels will best serve the country's overall needs and goals.

Regulatory Concerns

Construction and operation of synthetic fuel plants is governed by a large array of environmental and regulatory constraints. Numerous regulations affect land, air, and water use, and meeting them adds to the time and costs associated with the plants. In addition to the frustrations induced by this situation, a common fear of the participating firms is that once the requirements are met, someone will change them. A great desire of industry is a stable, predictable regulatory climate.

Both public utilities and interstate gas pipeline companies are interested in synthetic gas. The rate structures of these companies are determined by Federal and State laws. Regulatory decisions may affect the attitude of the investment bankers toward lending money to these ventures.

CONGRESSIONAL ACTION

The issues of research and development, as well as commercialization of first generation coal conversion technologies, was addressed in the ERDA authorization legislation for both 1976 and 1977. The fiscal year 1976 authorization bill (Public Law 94–187) provided $96.8 million for coal liquefaction and $92.4 million for high- and low-Btu gasification. In the second session, H.R. 12112 was introduced as a supplemental authorization for 1976 to provide $4 billion in loan guarantees for a commercial demonstration program of first generation coal gasification technologies. The consideration of this bill brought more than the financial issues surrounding the synfuels program into focus. It also examined the technical, environmental, and socio-economic problems that may accompany the development of synthetic fuels. The debate also examined alternative incentives.

The fiscal year 1977 appropriations for fossil fuels in ERDA were enacted as Public Law 94–373. The bill provided $73.9 million for coal liquefaction and $77.1 million for high and low Btu gasification. The fiscal year 1977 authorizing bill, H.R. 13350, provided $81.1 million for coal liquefaction and $109.2 million for high and low Btu gas. However, since the 94th Congress adjourned without adopting the conference report (H. Rept. 94–1718), the measure was reconsidered in the 95th Congress. Before adjournment, the House and Senate agreed to a "continuing resolution" that permitted ERDA to spend up to the levels contained in the fiscal year 1977 appropriations bills already enacted, except where the appropriation is for a new activity not included in the previous fiscal year's authorizing legislation.

In the 95th Congress, the House and the Senate debated economic means to stimulate the demonstration of synthetic fuel technologies. With the enactment of Public Law 95-238, which authorized appropriations for the Department of Energy, Congress provided a loan guarantee provision for producing alternative fuels from coal, oil shale, biomass, and other domestic resources. Under the provision, the Secretary of Energy will be authorized to guarantee loans to companies seeking to demonstrate technology for tapping alternative fossil energy sources. With the government pledging payment of these guarantees, this new initiative may remove some of the financial constraints on the demonstration of coal liquefaction and gasification, biomass, and oil shale facilities. Demonstration facilities may yield important information concerning the technological, economic, and environmental costs and benefits of synthetic fuels.

NATIONAL ENERGY PLAN PART II AND OTHER OPTIONS

Currently, the Department of Energy is developing a program that might be issued as the *National Energy Plan Part II.* It is reported that this plan will call for major new efforts to stimulate alternative energy production, primarily synthetic fuels from coal and oil shale. The details of this plan have not yet been officially released. If the Congress decided it was in the national interest to accelerate by 1990 the innovation of a substantial coal synfuels industry—one producing roughly .5 million barrels of synthetic liquids and 1,500–2,500 million cubic feet of synthetic gas per day—the following incentives may need to be examined:

1. A loan guarantee program which could entail $10–35 billion. Price supports, Federal procurement, or other cash sharing arrangements would likely be required for some synfuel projects.
2. A Federal regulatory system that provided a favorable environment for innovation. This system could allow attractive oil and gas pricing arrangements and rapid regulatory decisions.
3. A program to ensure long-term supplies of water and other materials necessary to support the requirements of a large number of synfuel projects.
4. A program to build the first few commercial-size facilities before 1985.
5. A program to reduce the social and economical impacts of these large-scale synfuel projects.

However, because of the known and unknown consequences of synfuels development, congressional actions seeking to stimulate this industry may have to be balanced by cautious concerns for the environmental integrity of the lands involved. Careful oversight and control of this emerging industry could be coupled with any provision to stimulate its growth. Vigorous efforts to meet and enforce reasonable environmental and regulatory practices may prove to be compatible with a competitive synfuels industry.

ALCOHOL FUELS: METHANOL, ETHANOL, GASOHOL

(By Migdon R. Segal)*

Methanol and ethanol are chemical compounds that are classified as alcohols. The formula for methanol is $CH3OH$, and for ethanol it is $C2H5CH$. The popular reference to methanol is wood alcohol, and ethanol is popularly known as grain alcohol.

Both of these compounds are combustible and can be used as fuels. From time to time, the possibility of using methanol or ethanol as an automotive fuel has been considered. Ethanol, in particular, was used in this way in a number of countries during the 1930s and 1940s. However, the idea of using the alcohols as a substitute for gasoline faded away in the late 1940s, because of the availability of inexpensive crude oil with which they could not compete economically. From a technical point of view, the use of either methanol or enthanol as an automotive fuel is completely feasible. The only restrictions on their use for fuel are those of economics and supply. However, these restrictions can be formidable, especially in the case of ethanol. The following sections described the potential of both methanol and ethanol as automotive fuels, and discuss some of the problems associated with their use in this manner.

METHANOL

Background.—Methanol is the lightest of the chemical compounds known as alcohols. It should not be confused with methane, which has received some attention recently as a possible alternative fuel source. Methane is a gas at normal conditions, while methanol is a liquid—a difference that gives a considerable advantage to methanol as a potential automotive fuel.

Methanol is a widely used and well known chemical, with current annual U.S. production running at roughly one billion gallons per year. Currently, methanol is produced almost entirely from natural gas. Since natural gas is a petroleum-related product, methanol derived in this way would not be helpful, given the desire to move away from dependency on petroleum-based fuels. However, methanol may also be produced from coal, wood, or urban wastes. It is the potential use of methanol from these nonpetroleum sources that has attracted attention to methanol.

As an Automotive Fuel.—The first serious work on methanol as an automotive fuel was performed by Drs. Reed and Lerner at M.I.T., and published in an article in *Science* magazine. (Dec. 28, 1973: 1299–1304). Reed and Lerner proposed using methanol in a blend with gasoline, with 10–15 percent methanol in the mixture. Their test data indicate that the gasoline-methanol mixture provides more power than does gasoline alone, although theoretically methanol is a less powerful fuel than gasoline and power should therefore be reduced for a given volume of fuel. Other researchers have questioned this power increase. It is possible, however, for such an increase in power as a result of methanol causing more efficient engine operation. Reductions in pollution emissions are also claimed as a result of blending methanol with gasoline. The work done by Reed and Lerner and others shows that methanol is compatible with gasoline, can be added to gasoline in amounts up to 15 percent, and can be used in existing automobiles without engine modification. Blends containing more than 15 percent methanol are possible, but would require carburetor adjustment.

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*Excerpted from CRS Issue Brief of the same title. Migdon Segal is an analyst with the Science Policy Research Division, Congressional Research Service, Library of Congress.

While methanol is worth serious consideration as an alternative fuel source, there are a number of problems which must be evaluated and overcome before it could enter large-scale use. These include the following: (1) starting difficulties—the latent heat of vaporization of methanol is higher than that of gasoline, and methanol is therefore slow to vaporize in a cold engine; (2) phase separation—methanol has only limited solubility in gasoline, and the methanol-gasoline mixture may therefore separate into two layers, particularly if water is present; (3) materials problems—methanol will chemically attack certain plating compounds used in automobile fuel tanks; (4) toxicity—methanol is a toxic chemical, and measures would have to be taken to educate the public about its toxic properties if methanol were to be introduced into general use.

FCE Movement of Natural Gas

Methanol has been discussed as a possible form for the low-cost movement of natural gas. The natural gas would be converted to methanol and shipped by pipeline or tanker. It has been suggested that this might be cheaper than moving natural gas in its original form, for example, from the North Slope of Alaska to the continental United States.

Potential Supply Sources of Methanol

Coal.—Of the nonpetroleum sources of methanol, the one closest to practical development is coal. The technology for obtaining methanol from coal is well known, and the nation's coal resources are ample to support obtaining significant quantities of methanol in this way. The original Reed and Lerner paper assumed that methanol would be obtained from coal.

The adequacy of the supply of methanol from coal is shown in the following approximate calculation.

The United States consumes about 100 billion gallons of gasoline per year in private automobiles. Assume that 10 percent methanol were to be used, and that this consumption rate remained constant. Ten billion gallons of methanol would then be required. This is about 60 billion pounds, or 30 million tons of methanol that would be required. Dr. Reed believes that the efficiency of converting coal to methanol would be about 50 percent. Therefore, in order to obtain 30 million tons of methanol, 60 million tons of coal per year, a little over 10 percent of our present coal output would have to be converted to methanol to obtain enough to provide a 10 percent mixture for all American automotive needs. This would involve expanding methanol production in this country by a factor of ten, which would require a considerable effort in terms of plant construction.

The latest estimate is that methanol could be produced from coal at roughly 38 cents per gallon. This would be comparable to 34 cents per gallon for gasoline before taxes. However, methanol has only half the energy value per gallon that gasoline does, so enough methanol to equal a gallon of gasoline would cost 76 cents. Methanol from wood and urban wastes would probably cost about the same as methanol from coal, or perhaps a little more. (Estimates on these costs are quite sketchy.)

Wood.—The development of a process for obtaining methanol from wood has been considered by the Office of Energy Resources of the State of Maine. Based upon the estimates being used by the Main researchers, the following calculation shows that there is enough forest land in the United States to make the methanol content of these forests a significant resource.

The Maine project estimates are that 2,250 gallons of methanol can be obtained per acre of forest land. (It is assumed that 7 pounds of wood will yield 1 gallon of methanol.) According to Reed and Lerner, commercial forests now cover 23 percent of the land area of the United States (520 million acres). Thus, the 5 million acres of Maine timberland that is proposed for methanol project represents about 1 percent of the national total.

The United States consumes about 100 billion gallons of gasoline per year in private automobiles. Assume that 10 percent methanol were to be used nationwide. This would require 10 billion gallons of methanol. At 2,250 gallons from one acre, roughly 4.5 million acres of forest would be required per year to meet this demand for methanol. This is less than 1 percent of the national total forest acreage.

It would appear, then, that the demand for enough methanol to provide a 10 percent blend with automotive gasoline could be met from U.S. forest resources. Such a large-scale use of wood for methanol might strain those resources, when added to the present requirements for paper, timber, and other wood products. However, proper forest management (replacing the land thus "harvested") would help to alleviate this problem.

We must emphasize that this calculation is speculative, depending upon the estimates of the Maine Office of Energy Resources—estimates which they readily admit have to be tested in the field before they can be fully accepted.

Urban wastes.—The concept of obtaining methanol from urban wastes has been actively explored in recent months by two West Coast groups—"Project Edict" in California and "Math Sciences Northwest" in Washington. However, neither of these groups was able to obtain sufficient support to move beyond the "paper study" phase of research. The studies performed were, as follows:

"Project Edict" (Calif.)—This project was led by Scott Carpenter (former astronaut). Carpenter's group performed a 4-month study under a contract with the State of California. The study called for a "pyrolysis plant," with an input capacity of 50 tons per day, which would be used to produce methanol. The raw material processed in this plant could be "almost anything," according to Carpenter, with the leading candidates being wood and urban wastes. For urban

wastes, he estimated that 60 gallons of methanol would be produced per ton of waste, or 3,000 gallons per day of methanol output.

"Math Sciences Northwest" (Wash.). Richard Corlette was in charge of the study performed by this private group for the City of Seattle, Wash. The study was a 90-day effort intended to find the best way for Seattle to dispose of its municipal waste. It seemed to be a thorough effort, involving a number of subcontracts and engineering studies. The conclusion was that Seattle should convert its urban waste to methanol. Corlette stressed that what was good for Seattle would not necessarily be good for other cities. The best course for disposal of urban waste depends upon a number of local factors including climate, availability of land for landfill, availability of electrical power sources, etc. For Seattle, a shortage of land in the immediate area made landfill disposal unfeasible, cheap hydroelectric power for generating power from waste was unnecessary, thus, production of methanol became a reasonable alternative.

Conclusion

It appears that methanol as an automotive fuel could make a significant contribution toward relieving the "energy crisis" and reducing this country's dependence upon foreign sources of petroleum. However, this is a tentative conclusion pending further analysis as regards technological problems and the economics of the processes by which methanol would be obtained from coal, wood, or urban wastes. If 10–15 percent of our gasoline requirements could, in fact, be replaced by methanol, without significant increases in price or decreases in engine performance, this would be a valuable contribution to this nation's energy independence.

ETHANOL

The idea of using ethanol as an automobile fuel is not a new one. During the 1930s, the use of grain alcohol in a blend with gasoline as an automobile fuel was widespread in a number of countries around the world where petroleum was in short supply. (It was not used in this manner in the United States in any major way.) During World War II, this practice was continued and even expanded, as the disruption caused by the war led to gasoline shortages around the world. Not only alcohol, but other substances such as wood, charcoal, cow manure, and the like, were used in many areas. Germany, which was particularly in need of fuel for its war machine, developed an entire industry for producing gasoline from coal.

Within a few years after the end of war, practically all these substitute materials had been dropped in favor of gasoline produced from crude oil. The reason for this change was basically an economic one. Neither alcohol nor any of the other alternative fuels could compete with the flood of cheap, readily available crude oil that entered the world market at that time.

The posibility of using grain alcohol as an automobile fuel was discussed periodically during the 1950s and 1960s, when the intent was to dispose of the enormous grain surpluses then existing in this manner. In recent months the oil shortage has once again spurred interest in ethanol as a fuel. However, the idea appears to suffer serious flaws in current circumstances. The problems are (1) the high price of fuel produced in this way, and (2) the immense quantities of grain that must be consumed to fill even a small portion of the energy needs currently provided by petroleum.

The leading expert in the country on this problem is Mr. Dwight L. Miller, Assistant Director of the Northern Regional Research Laboratory, Department of Agriculture, in Peoria, Illinois. (Mr. Miller was consulted while preparing the following information.)

Price.—Until the economic dislocations caused by the recent shortages, there was no question that grain alcohol, as a fuel, was far more expensive than gasoline. In fact, it has also been more expensive than synthetic alcohol, which is produced from petrochemicals. Therefore, if it were decided to use alcohol as an automotive fuel, petroleum-based alcohol would have the cost advantage over grain-produced alcohol. While the cost of crude oil has been rising rapidly, the cost of grain has also been increasing. The net result is that the recent price rises have somewhat narrowed the gap between grain alcohol and petroleum products, but not enough to erase the advantage the oil-based products have. The best estimate is that alcohol produced from grain today would cost at least $1.10/gallon. This is a base cost only, and it does not include the costs that would be added by distribution, sales expenses, and profits, nor does it include the cost of the many refineries that would have to be constructed in order to convert grain to alcohol on a large scale.

Supply.—Mr. Miller provided the following information. Gasoline used by automobiles in the United States in 1973: 103 billion gallons. Assuming a 10 percent alcohol mixture, 10.3 billion gallons required. Grain needed for this amount of alcohol: 4.0 billion bushels. Total U.S. harvest (feedgrains, wheat, etc.): 10 billion bushels.

Therefore, in order to provide a 10 percent contribution to the automotive fuel problem, the United States would have to use 40 percent of its grain harvest. Putting it another way, *all* our grain harvest, if burned as fuel, would only fill 25 percent of our automotive needs.

Thus, even if the cost situation were to change dramatically, the supply problem would make the use of grain-derived ethanol impractical on a larges scale (although specialized limited uses may be feasible).

The situation may perhaps be different in Brazil, which has begun an active program intended to obtain fuel from crops. Brazil has an enormous land area, most of which supports the growth of vegetation in great profusion. Also, as a developing country its fuel needs are considerably less than those of the United States. Brazil has committed more than $400 million to a program of obtaining alcohol from plants since it began this program in November 1975. The program is intended to obtain ethanol from sugar cane and from manioc, a root crop that grows in all parts of Brazil. Gasoline blended with locally produced alcohol has now gone on sale in Brazil.

In this country, the State of Nebraska has taken the lead in ethanol research. Work sponsored by the State government has produced a fuel called "gasohol", which is a 90–10 mixture of gasoline and ethanol. No adverse effects on automobiles running on this blend were reported. Nebraska plans to build a 20-million-gallon-per-year alcohol plant for this purpose. This would supply only 0.02 percent of the total U.S. automotive fuel requirements.

An experimental program, under development at the U.S. Army laboratories in Natick, Mass., uses a fungus to transform cellulose waste matter to glucose, which is then fermented to produce ethanol. This project, if ultimately successful, could provide a new source for ethanol. However, the Natick process is still at an early stage of development, and speculation as to the economic and technical problems that might be encountered in transforming this laboratory process to a large-scale manufacturing plant would be premature.

The Mobile Oil Company has developed a catalytic process which would convert alcohol to gasoline, at an added cost of about 10 cents per gallon. This concept, should it prove feasible, would elmiinate any materials and distribution problems involved in the alcohol-gasoline blend.

B. The Process of Energy Research, Development, Demonstration and Commercialization

THE ENERGY RESEARCH, DEVELOPMENT, DEMONSTRATION AND COMMERCIALIZATION PROCESS*

The R, D, D, and C process, which involves the creation, accumulation, dissemination, and use of knowledge, combines two disciplines: science and engineering. When commercialization is involved, economics and finance also become important.

Scientists and engineers, by the nature of their disciplines, are likely to focus on individual segments of the process, such as the scientific basis and feasibilty of fusion or the design of less expensive or more reliable synthetic fuel plants. Economists and financiers are concerned more with profitability and risk in the marketplace.

Policymakers must take a broader view of the many factors that make possible the completion of the process, including the desirability of a technology itself, budgets for support (and the competing claims on those budgets), and the extent and timing of participation by the private sector.

As a technology (solar, nuclear, etc.) moves from research through development to demonstration and commercialization, it will at each step make varying demands upon scientific and engineering personnel, funding, and market incentives. The characteristics of success will also vary at each of the four stages. Progress will depend on what has already been learned, what can be achieved in any particular stage, and any major uncertainties that might surround the project at a given stage. It is this information component that ought to determine how quickly decisions can be made about ultimate disposition of the technology.

The distinctions between successive stages in the R, D, D, and C process are rarely clear. Indeed, the process can be viewed as a continuous one, in which the nature and volume of information available is constantly—if often almost imperceptibly—changing. As the information changes, so do the questions which must be asked next. The first questions tend to be scientific, but as the technology matures, engineering, economic, and institutional questions become increasingly important.

It is not surprising that problems arise even with definition of the terms research, development, demonstration, and commercialization. Yet there are important distinctions which have to do with the nature of information to be gained, the appropriate policy instruments to be used, and the timing of major decisions. The following discussion of each of the stages may help to clarify their relation to each other and to the entire process.

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*From Energy Research, Development, Demonstration, and Commercialization p. 5–11. Written and published by the Congressional Budget Office, January 1977.

RESEARCH AND DEVELOPMENT

Research and development is generally designed to gather information about theoretical and technical uncertainties and to carry the investigation to a point where it is possible to determine the technical feasibility of a technology or process.

The distinction between research and development is difficult to make and, with the exception of certain "basic research" programs, is rarely made in practice. (It is also unnecessary for the purposes of this paper, because of the relative funding levels involved. However, this is not to say that basic research can be ignored in comparison to later stages that generally cost more.) Research is now being carried out in the fusion program, for example, to show whether it is possible to extract more energy from the process than it consumes. This break-even point will determine, at a very basic level, whether fusion can possibly become a source of energy. In the solar area, for another example, photovoltaic (light to electricity) materials can convert sunlight to energy. However, to become an economic energy source, the photovoltaic process requires the production of huge quantities of material that have uniform, reliable characteristics. Techniques for manufacturing this material in quantity and at competitive costs need to be established. Likewise, production of oil or gas from shale requires the development of *in situ* techniques to extract these materials from the shale while it remains in the ground.

The information gained in the research and development stage about basic feasibility, about subsidiary problems like materials performance, and about necessary design features will determine whether and how a demonstration is to be carried out.

DEMONSTRATION

It is appropriate to begin the demonstration stage when basic uncertainties have been resolved and the new information gained indicates that the demonstration will generate information about other remaining uncertainties associated with a much larger scale effort. For energy technologies, such uncertainties are likely to be economic, environmental, or institutional in nature. The point of constructing a demonstration project at near-commercial scale is not simply to increase its size, but to find answers to still unresolved questions that can only be found with a model constructed on this larger scale. For example, environmental impacts will be more extensive and measurable, the institutional impediments may be more apparent, and the costs are likely to be far greater than those incurred in earlier stages.

All of these uncertainties—economic, environmental, institutional—need not exist in order to justify a demonstration project. Each demonstration will have a specific combination of factors, some of which are well known and some of which pose substantial uncertainties. In general, technical feasibility is, or should be, better known than other factors, because feasibility relates more closely to technological principles (e.g., the laws of physics) that generally are not altered by enlargement; and because feasibility can be tested at a smaller scale more quickly and less expensively.

The demonstration project can be designed to address these problems as well as the viability of the technology at a scale close to commercial operation. Indeed, if a new energy technology were known to be feasible and reliable; if the cost of its operation at a commercial scale were well understood; if its environmental effects were well catalogued and techniques for mitigating such effects were well in hand; if its price were competitive with alternative sources; and if this knowledge were perceived by users and suppliers, there would be no reason to undertake a demonstration. The technology could be put into commercial production immediately.

In a recent study by the Rand Corporation,[1] a large number of federal demonstration projects in many areas were evaluated with regard to success in demonstrating the technology, diffusing the knowledge gained, and accelerating commercial implementation.[2]

The study concluded that the elements of a successful demonstration tended to include: (1) a technology well in hand; (2) cost and risk-sharing with nonfederal participants; (3) project initiatives from nonfederal sources; (4) the existence of a strong industrial system for commercialization; (5) inclusion of all participants needed for commercialization; (6) absence of tight time constraints.

Those conclusions are relevant to the present discussion in several ways. First, it is clear that an important factor in the success of a demonstration is that the technology be ready to leave the R and D stage (i.e., uncertainties about technical feasibility are resolved). A demonstration designed to uncover a large amount of new information about technical feasibility or environmental effects is less likely to provide a system ready for commercialization and could more appropriately be carried out as an R an D project. Second, demonstration projects should include major private sharing in the initiation, planning, and funding to create the conditions—particularly the existence of direct experience—which enhance the likelihood of ultimate commercialization.

These findings would indicate that complete funding by the federal government, with a dominant federal planning and management presence, makes ultimate commercial success less likely. Rand cited, as an example of a demonstration project that was successful in encouraging commercialization, the Yankee Atomic nuclear power plant, built and managed by a utility consortium with less than 20 percent of costs borne by the federal government.

COMMERCIALIZATION

The final stage in the progression of a new technology is its commercialization, i.e., its implementation in a commercial or production framework.[3]

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[1] Rand Corporation, *Analysis of Federally Funded Demonstration Projects*, April, 1976.

[2] In the context of this paper, commercialization is not meant to include the implementation of already existing and unchanged technologies such as strip-mining of coal or light water nuclear power plants, but rather the implementation of new or emerging energy technologies.

[3] It is often said that federal energy R and D programs are designed to "push technology" which is developed independent of demand, while commercialization programs represent "demand pull" in which technologies which are ready to produce energy at competitive prices are implemented.

Most technological innovation, of course, needs no government intervention to encourage commercial adoption if an appropriate market exists. The market rewards successful innovation with profits and punishes failures with losses. Government action to commercialize a technology becomes necessary only when two conditions exist simultaneously: (a) a promise of substantial benefit to the nation or society from that technology, and (b) a market environment that does not encourage its adoption.

The kind of marketplace obstacle to commercialization varies with the technology to be introduced; therefore the type of government action necessary to remove the obstacle will vary. If, for example, the obstacle is not technical feasibility or costs, but the inability of the private sector to raise large amounts of investment capital, then a government commercialization program including direct grants, loans, or loan guarantees might be appropriate. If, on the other hand, the obstacle were the availability of competing lower-priced energy sources, some from of price supports might be helpful. However, government intervention to reduce one type of obstacle will generally not be appropriate for the other and may even be counterproductive. These varying roles and instruments are discussed in Chapter IV.

There are precedents for government provision of commercialization incentives. The nuclear power industry, for example, was helped to the commercialization stage with insurance incentives (the Price-Anderson Act).

Costs are likely to be the largest at the commercialization stage because the scale of effort is largest. This does not necessarily mean that the cost to the government will be proportionately high, because private industry may be more willing to accept an important share of costs at this stage when profits may soon be realized.

Table 1 summarizes the characteristics of each stage of the R.D.D. and C process: the type of information to be gained, the different roles and mechanisms that the federal government could adopt, and the relative costs.

TABLE 1.—CHARACTERISTICS OF R, D, D, AND C STAGES

	R. & D.	Demonstration	Commercialization
Information	Technical feasibility	Economic potential	Markets.
	Process condition	Costs	Risks.
	Basic cost	Environmental effect	Institutional.
	Environmental effect	Institutional factors	
Federal role	Grants	Cost sharing	Loan gurantees.
	Government laboratories	Government ownership	Price supports.
	Incentive for R. & D	Contracts	Guaranteed purchases.
	Dissemination of information	Dissemination of information	Cost sharing.
			Regulation.
Total relative cost	Lowest.	Mid.	Most (potentially).

C. The National Security Implications of U.S. Dependence Upon Foreign Sources of Petroleum

THE LEGITIMATE CLAIMS OF NATIONAL SECURITY

(By Maxwell D. Taylor)*

. . . We have dealt only with the military component of the problem of rationalizing and legitimizing claims of national security and have deliberately omitted extended consideration of nonmilitary threats and responses. These are omissions which must be accommodated in any comprehensive security program pretending to deal with all probable future dangers. In spite of the military orientation of this article, I for one am fully convinced that the most formidable threats to this nation are in the nonmilitary field.

One could hardly hope to find a better example of the seriousness of nonmilitary threats to national security than the present energy crisis. Our national valuables in many guises and over a wide span of our interests are endangered. On the domestic front, we may face retarded economic growth, higher costs of industrial production, new deficits in international payments, and increased inflation—all to the serious detriment of individual welfare and the quality of our national life.

On the international front, the oil situation will be an even greater disaster to our NATO allies, Japan, and many developing countries caught in the power play of the oil producers. Without prompt relief, the plight of the European and Japanese economies may bring about runaway inflation and a global recession which could easily involve us. A military consequence would be a further decline in the effectiveness of the NATO alliance and an added reason, the shortage of oil, to doubt the capability of NATO for prolonged self-defense.

For the U.S.S.R., the aggressive use of the oil weapon by the producer countries is a priceless asset, providing a peaceful and seemingly innocent means of undermining NATO and indeed the entire Western capitalist system without direct Soviet involvement. For the Kremlin, this must appear a thoroughly enjoyable economic war by proxy.

Contemplating such possibilities, one cannot deny that the oil issue affects American security in a vital sense in many ways. Yet, in spite of repeated warnings over the years, our government was caught largely by surprise, apparently without contingency plans to cope with it. While it may be overstatement to call it an economic Pearl Harbor, at a minimum our unpreparedness certainly demonstrates a lack of institutionalized responsibility in the executive branch for anticipating nonmilitary dangers and developing plans and programs to forestall them.

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*Reprinted by special permission from Foreign Affairs, April 1974. Copyright 1974 by Council on Foreign Relations, Inc. Maxwell D. Taylor was Chairman of the Joint Chiefs of Staff (1962-1964).

Hence, I would make a closing suggestion for dealing with this organizational deficiency. It is to create an expanded National Security Council charged with dealing with all forms of security threats, military and nonmilitary, and having access to all elements of government and to all relevant resources capable of contributing to this broad task.

Fortunately, the drafters of the National Security Act of 1947 seem to have anticipated this problem in the language defining the purpose of the National Security Council as being "to advise the President with respect to the integration of domestic, foreign, and military policies related to national security." In practice, however, the National Security Council has concerned itself almost exclusively with issues of foreign and military policy, paying only incidental attention to relevant domestic matters and almost none to environmental factors of such critical importance to our security as the population explosion. It has never attempted to establish relative priorities between domestic, foreign and miltary demands on national resources. With an appropriate expansion of membership to give representation to the domestic and environmental sectors and perhaps with a modification of title (I would prefer "National Policy Council"), the Council could be held to a more exacting compliance with its 1947 mandate. In this expanded form, the body could design a comprehensive national security program meeting criteria of rationality and legitimacy such as I have proposed for the military component.

Success in this comprehensive effort could accomplish many things. The expanded Council could afford a forum for expresssions of concern over the primacy felt to be accorded foreign programs at the expense of the domestic. It could improve the integration process for blending military and nonmilitary components of national power and, in so doing, demonstrate the dependence of all forms of national policy on the same sources of national strength. In time we might succeed in correcting the misconception that national security is somehow the sole responsibility of the military, and in inducing its acceptance as a task for us all. If, in the end, this process brought forth a national security program which made clearly legitimate demands on national resources for obviously sound reasons, we would have accomplished much in restoring national security to its rightful place in the public esteem. We might also have provided a unifying purpose for a badly fragmented society.

THE NATIONAL ENERGY PLAN: OPTIONS UNDER ASSUMPTION OF NATIONAL SECURITY THREAT

(By Frances A. Gulick)*

The President has defined the energy problem facing this country as one of grave and near-term danger to national security. He set U.S. energy demands in a world context, as an approaching crisis of the mid-1980's when world suppliers of oil would not be able or willing to export all the oil needed by the United States and the free world. The resulting international tensions, competition for imports of oil, and slowdown in the free world's economy would threaten "national catastrophe." The crisis point sometime in the 1980's, according to the President's perspective, is not self-imposed but will be determined by world events and trends which are now largely outside of domestic control.

THE PRESIDENT'S ASSESSMENT

In a nationwide address April 18, 1977, the President described the approaching dangers in very strong terms.[1]

> Tonight I want to have an unpleasant talk with you about a problem that is unprecedented in our history. With the exception of preventing war, this is the greatest challenge that our country will face during our lifetime.
>
> The energy crisis has not yet overwhelmed us, but it will if we do not act quickly * * *.
>
> The oil and natural gas that we rely on for 75 percent of our energy are simply running out * * *.
>
> Our Nation's economic and political independence is becoming increasingly vulnerable. Unless profound changes are made to lower oil consumption, we now believe that early in the 1980's the world will be demanding more oil than it can produce * * *.
>
> We will constantly live in fear of embargoes. We could endanger our freedom as a sovereign nation to act in foreign affairs. Within 10 years, we would not be able to import enough oil from any country, at any acceptable price * * *.
>
> Inflation will soar; production will go down; people will lose their jobs. Intense competition for oil will build up among nations and also among the different regions within our own country. This has already started.
>
> If we fail to act soon, we will face an economic, social, and political crisis that will threaten our free institutions.

Seven months later, the President warned again of the encroaching threat to national security if the rising dependence on foreign oil is not reversed soon.[2]

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*A Report printed for the use of the House Committee on Interstate and Foreign Commerce and the Senate Committee on Governmental Affairs, March 1978. Frances A. Gulick is an analyst in energy policy, Congressional Research Service, Library of Congress.

[1] The President's address to the Nation, Apr. 18, 1977, in Weekly Compilation of Presidential Documents Monday, Apr. 25, 1977, vol. 13, No. 17.

[2] The President's address to the Nation, Nov. 8, 1977, in Weekly Compilation of Presidential Documents, Monday, Nov. 14, 1977, vol. 13, No. 46.

If this trend continues, the excessive reliance on foreign oil could make the very security of our Nation increasingly dependent on uncertain energy supplies. Our national security depends on more than just our Armed Forces; it also rests on the strength of our economy, on our national will, and on the ability of the United States to carry out our foreign policy as a free and independent nation. America overseas is only as strong as America at home.

The Secretary of Defense said recently, "The present deficiency of assured energy sources is the single surest threat * * * to our security and to that of our allies."

STATEMENT BY THE SECRETARY OF DEFENSE

The Secretary of Defense elaborated this concern in his testimony before the House Ad Hoc Committee on Energy on May 4, 1977;[3]

> I do believe my present responsibilities as Secretary of Defense make me aware of the very substantial impact, in fact, the crucial nature, of the energy shortage and of the need for a U.S. program to redress it. In fact, there is no more serious threat to the long-term security of the United States and to its allies than that which stems from the growing deficiency of secure and assured energy resources* * *.
>
> The threat to national security, the economy and our way of life which arises from the energy crisis is not yet fully recognized by all. Some refuse to accept the fact that the energy crisis is real, and that its solution will require the development of a national policy and purpose commanding the dedication of the Nation, its resources, and its people over many years. Ultimately, the only alternative is disaster.
>
> We are all familiar with the continuing risk of oil supply interruptions and upward pressures on prices from politically motivated embargos such as we experienced 4 years ago. Much less attention has been given to the potential for a much more serious interruption of oil supply by hostile forces in time of war. In the event of some future confrontation, the Soviet Union might be able to restrict access of the Western World to its essential oil supplies to a degree of severity and duration greater than any embargo by the oil producers. The U.S.S.R. might attempt to deny access to the oil of the Persian Gulf by direct attack on the facilities of the major oil-loading ports, which lie near Soviet territory. Simultaneous action to interdict on the high seas tanker movement of oil from other exporting nations could vastly exacerbate the oil supply situation for the United States and its allies.
>
> The military, political, and economic risks of oil interruption are very real, and are steadily increasing as dependence on imported oil continues to grow * * *.
>
> There is a third and greater energy threat to the Nation which has until recently received all too little popular attention, but which, as the President has said, should be the foremost consideration in development of national energy policy. This third threat is neither military nor political. It is, quite simply, resource depletion. A finite world supply of oil and gas will soon repeat the cycle so long evident in the United States. Growth in producible reserves will slow, halt and then go into decline as the remaining proven undiscovered resources grow smaller and the rate of discovery diminishes in the face of steadily increasing demand. The annual expansion in worldwide production which has been the foundation of 20th century world economic growth will level off and begin to decline.
>
> Arguments that much greater hydrocarbon reserves remain to be discovered miss the point. A growing consumption rate assures that even if so they too will be quickly consumed * * *.
>
> I believe there is comparatively little time for the United States to respond to the President's call and move toward reducing its dependence on imported oil. Failure to do so will impose increasing risks to our national security in the next few years and lead inexorably to the collapse of the world oil supply/demand balance in the next decade. Should that occur the effects on the security and economic viability of this Nation and the free world will be catastrophic.

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[3] Hearings before the Ad Hoc Committee on Energy, U.S. House of Representatives, 95th Cong., 1st sess., on the National Energy Act. Hearings held on May 4, 5, and 12, 1977, pp. 60–72.

PRIMARY FEDERAL TASKS IN A NATIONAL SECURITY RESPONSE

Almost by definition and by law and precedent,[4] any program designed to cope with a serious threat to national security serves to legitimate a leading Federal role. This role involves several complementary activities:

PRIMARY EXECUTIVE RESPONSIBILITY

Previous experience has featured an executive branch with primary responsibility for shaping and launching the Nation's response, particularly to:

1. Identify the nature of the threat and design the response.
2. Set quantitative targets for industrial goods, manpower, production of additional munitions, fuels and other resources needed to offset or at least forestall the threat.
3. Direct large scale procurement of the goods and services needed.
4. Determine and award priority access to critical materials to serve production targets alined with national security goals, and restrict nonpriority uses when required.
5. Enlist and mobilize broad participation and support from State and local governments and the private sector as a whole.
6. Maintain the strength of the international collective security system.

THE SUPPORTING CONGRESSIONAL ROLE

The role of Congress in national security emergencies has been primarily one of authorizing and supporting executive initiatives, particularly to:

1. Authorize, where needed, the exercise of existing contingency emergency powers.
2. Enact additional tax, loan guarantees and investment write offs designed to accelerate industrial plant conversion and to offset wartime risks.
3. Appropriate additional funds as required to pay for federally procured goods and services or other programs to meet the goals.
4. Supplemental executive policy and program initiatives with congressional proposals developed independently if executive programs appear to be inadequate.

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[4] Among general studies of earlier U.S. experience are: "The United States at War: Development and Administration of the War Program by the Federal Government"; prepared under the auspices of the Committee of Records of War Administration by the War Records Section, U.S. Bureau of the Budget, DeCapo Press, New York, 1972, 555 p. "Industrial Mobilization for War: History of the War Production Board and Predecessor Agencies, 1940:1945," vol. I, Program and Administration. Prepared by the Bureau of Demobilization, U.S. Civilian Production Administration, 1947, published by the U.S. Government Printing Office, 1009 pp. "Administrative Reflections from World War II," by Luther Gulick, University of Alabama Press, 1948, 139 p. Industrial production experience during World War II and the Korean War was reviewed and analyzed in "Materials Shortages. Selected Readings on Energy Self Sufficiency and the Controlled Materials Plan." Prepared by CRS for the permanent Subcommittee on Investigations of the Committee on Government Operations. U.S. Senate. Committee print, August 1974, 256 p. and "Workshop on Resource Management," Committee print, report published by the same Senate committee, February 1975, 76 p.

The wartime experiences, including the prewar periods of preparation, from which these generalized precedents have been drawn are not directly comparable, even with each other: World War II involved much more widespread controls and more complete mobilization and conversion to war production of the national industrial base than did the Korean or the Vietnam wars.

In all instances, however, large-scale, direct Federal procurement of goods and services, in pursuit of production goals alined with national security objectives, provided the primary Federal management tool by which such national production goals could be both established and achieved.

NATIONAL ENERGY PRINCIPLES IN THE CONTEXT OF A NATIONAL SECURITY RESPONSE

The President presented 10 fundamental principles as the underlying rationale for the national energy plan and the framework within which present and future policies must be formulated.[5]

THE 10 PRINCIPLES

In summary, the 10 principles are:

(1) The energy problem can be effectively addressed only by a government that accepts responsibility for dealing with it comprehensively and by a public that understands its seriousness and is ready to make necessary sacrifices.

(2) Healthy economic growth must continue.

(3) National policies for the protection of the environment must be maintained.

(4) The United States must reduce its vulnerability to potentially devastating supply interruptions.

(5) The program must be fair. The United States must solve its energy problems in a manner that is equitable to all regions, sectors, and income groups.

(6) The cornerstone of national energy policy is that the growth of energy demand must be restrained through conservation and improved energy efficiency.

(7) Energy prices should generally reflect the true replacement cost of energy.

(8) Both energy producers and consumers are entitled to reasonable certainty as to Government policy.

(9) Resources in plentiful supply must be used more widely and the Nation must begin the process of moderating its use of those in short supply.

(10) The use of nonconventional sources of energy—such as solar, wind, biomass, geothermal—must be vigorously expanded.

There has been very little public disagreement with these principles. Although the plan's goals and accompanying programs and policies have been assessed in depth in a wide range of official and unofficial studies, the principles themselves have received relatively little analysis and attention.

It may be useful to review the underlying rationale reflected in the principles to determine whether they reflect the national security dimensions and urgency of the energy problem which the President and the Secretary of Defense have publicly described. The first, sixth, and seventh of the principles laid down in the national energy plan arguably do not.

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[5] The National Energy Plan, pp. 25–32.

THE FEDERAL ROLE

The national energy plan describes the Federal role as follows:

> The first principle is that the energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively, and by a public that understands its seriousness and is ready to make necessary sacrifices. The declining availability of oil and natural gas will affect virtually all energy prices and consumption patterns in the United States, for the various energy supplies are all part of an integrated energy market. Therefore, in this democratic society, a solution can be found only in comprehensive Government policymaking informed by public comment and supported by public understanding and action.
>
> The Federal Government can pass laws and encourage action. State and local governments can play active role. But this society can function at its best only when citizens voluntarily work together toward a commonly accepted goal. Washington can and must lead, but the Nation's real energy policy will be made in every city, town, and village in the country.

Comment

The fact that "declining availability of oil and natural gas will affect virtually all energy prices and patterns of consumption in the United States" may not be considered a self-evident reason for "comprehensive Government policymaking." A substantial congressional and public constituency has argued the opposite case, namely, that to remove current Government price and other regulatory control on oil and natural gas would enable the economy as a whole to adjust to a new "integrated energy market" with consumption patterns much more efficiently geared to the realities of declining oil and natural gas supplies, as prices rise to meet near-term replacement costs measured by or against the price of imported oil.

If, however, the rationale can be persuasively recast so as to reflect the threat to national and free world security, as the energy problem is elsewhere defined by the President, the assertion of a Federal policymaking role would presumably be far less objectionable to the public. The rationale could be rephrased along these lines:

> The first principle is that the energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively, and by a public that understands its seriousness, and is ready to make necessary sacrifices.
>
> The declining availability of oil and the increasing dependence of the United States and the free world on oil imports whose availability in volume sufficient to meet world demand cannot be assured presents an unacceptable risk to national and free world security. Therefore, a solution should be found in comprehensive executive and congressional leadership, informed by public comment, and supported by public and private understanding and action.

THE ROLE OF CONSERVATION AND PRODUCTION

Further possible incongruity between the problem and the principles as defined is revealed in the sixth principle of the plan, which sets forth the rationale for a dominant conservation role:

> The sixth principle, and the cornerstone of national energy policy, is that the growth of energy demand must be restrained through conservation and improved

energy efficiency. Conservation and improvement in energy efficiency is the most practical course of action for the United States and for the nations of the world. Conservation is cheaper than production of new energy supplies, and is the most effective means for protection of the environment.

Comment

As stated, this principle—as well as the complementary 9th and 10th principles calling for switching from oil to use of plentiful fuels and renewable resources—fails adequately to suggest the massive production effort on the other side of the demand-supply equation, which must be accomplished within a very short period of time. To do this will require large-scale replacement of existing petroleum-fueled capital stock with new equipment using other fuels, or large-scale construction of synthetic oil production capacity using domestic raw materials or some combination of these. This, in turn, would require very substantial production efforts which, under the national security emergency thesis, would need to be accelerated to virtually wartime production rates.

Production of insulation is already insufficient to meet current demand. The manufacture of heat pumps and cogeneration facilities requires expanded production capacity that will need fuels and energy. When the fuel switching goals are added, the volume of production of new and improved energy-using equipment contemplated is formidable: Fluidized bed combustors, scrubbers, and other facilities to prevent environmental damage, a wide variety of solar-collecting and solar-using hardware, recycling equipment, solid waste conversion plants, methane and methanol and ethane and ethanol production systems, electric cars, batteries and recharging units. Production of these kinds of industrial equipment must be in addition to the massive production effort implied in the plan's fuel balance tables to increase domestic supplies of nuclear energy, from 1976 levels of 1.0 MMb/doe[7] to 3.8 MMb/doe; coal, from 7.9[7] MMb/doe to 14.6 MMb/doe; and domestic oil, from 9.7 MMb/d to 10.6 MMb/d.

To repeat, reduction of oil import dependence will not take place as a result of belt tightening alone; a major production effort will be required to produce the products which use non-petroleum-based fuels alternative to oil and use all fuels more efficiently.

The language used in the plan's statement of this principle, comparing the costs of conservation to production of new energy supplies,[8] suggests a failure to identify the fact that the financial problems confronted by energy *users*, on whose individual decisions the plan heavily relies, are very different from those of oil and natural gas *producers*.

Oil and natural gas producers have traditionally financed new investment out of current cash flows, rather than through borrowing. Few energy end-users, small or large, residential or industrial, enjoy such luxury. Most must borrow at commercial rates.

Furthermore, oil and gas producers have a guaranteed market for their products for a long time to come, and can reasonably expect that profits will not diminish in the near future. Industrial energy users called upon to switch from oil and gas to alternative fuels when there may still be 10 or more years of economical and productive use in existing boiler or generating plant risk losing competitive markets for their products if the full cost of the added capital plant replacement is passed on to the consumer, or taking a substantial cut in profits if it is not. Even greater risks face the individual householder whose available cash and credit may already be stretched to the limit.

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[7] MMb=Million barrels per day oil equivalent.

[8] I.e. "Conservation is cheaper than production of new energy supplies."

The continued sluggishness in the U.S. and free world economies discourages bold private investments now for a future postpetroleum age.

The sixth principle could be enlarged to reflect the reality that a massive industrial and energy production effort will be needed even to achieve the plan's own quantitative goals and that Federal procurement of industrial goods enabling large-scale conversion of fuels other than oil may be needed to meet the goals within the time frame of 1985. That principle might be restated:

> The cornerstone of national energy policy is that the nation's dependence on industrial production effort to permit the necessary switching to fuels other than imported oil must be reduced through accelerated programs to achieve conservation and improve efficiencies of energy use concurrent with a major energy and conventional oil and natural gas, without damage to the environment. Federal procurement contracts should be used to accelerate and expand the capital plant production and conversion efforts needed in the private sector to meet the Plan's quantitative goals.

ENERGY PRICING CONCEPTS

Similarly, the seventh principle, which sets the basic framework for the plan's energy pricing policies, appears to suggest that the size and pace of national production and conversion effort designed to deal with threats to national security should be left primarily to individual and collective market choice:

> The seventh principle underlying the national energy plan is that energy prices should generally reflect the true replacement cost of energy. Energy prices should move toward a level that reflects the true value of energy in order for market signals to work in harmony with conservation policy. When the cost of expensive foreign oil is averaged with cheaper domestic oil, consumers overuse oil. Government policy that promotes overuse by artificially holding down prices misleads consumers into believing that they can continue to obtain additional quantities of oil at less than its replacement cost.
>
> Artificially low prices for particular energy sources also distort interfuel competition. The artificially low price of natural gas, for example, has encouraged its use by industry and electric utilities ,which could use coal, and has made gas unavailable for new households, which could make better use of its premium qualities.
>
> Neither Government policy nor market incentives can create additional oil or gas in the ground. But from a long-term perspective, prices are an important influence on production and use. As long as energy consumers are enticed into believing that they can continue to pay yesterday's prices for tomorrow's energy they will continue to use more energy than the Nation can really afford, U.S. resources will be rapidly exhausted, and continued overuse will make the inevitable transition more sudden and difficult.
>
> Although producers need incentives for exploration and new development, pricing policies should not give them windfall profits unrelated to their economic contribution. If producers were to receive tomorrow's prices for yesterday's discoveries, there would be an inequitable transfer of income from the American people to the oil and gas producers, and producers' profits would be excessive.

Comment

This pricing approach does not appear consistent with the President's placement of the national energy problem in the context of grave impending danger to United States and free world security, and with the fact that the presidentially projected period of time to prepare for and surmount—or at least forestall—the threat is limited.

It is generally accepted that in times of national emergency or threat to security, Government intervention in the market to preempt and redirect resources to meet the emergency or danger is justified. Under these circumstances, existing pricing concepts are likely to be superseded by other pricing arrangements adapted to the particular emergency. In some instances, this may involve strict price controls over either the whole economy or, on a more selective basis, over materials and products in short supply, in order to control inflation. Emergencies are also likely to involve expanded Government procurement of necessary equipment, materials, or services in which the negotiated price may, for example, include a premium to offset financial risk or be calculated on a cost-plus-fixed-fee basis.

Additional subsidies or other incentives have also been made available for emergency situations, such as war risk insurance, extraordinary grants or loans for construction of new or expanded industrial plants including, where necessary, construction of plants to produce capital equipment in support of an expanded industrial base.

Nor has Government intervention designed specifically to distort market pricing in the public interest been limited to emergency conditions. For 50 years, the United States followed a *de facto* national energy policy that deliberately chose to subsidize private producers to produce oil and natural gas, with the objective of providing expanding energy supplies at the lowest possible cost consistent with reliability of supply. The policy served the United States' domestic social goals for many years. It enhanced personal mobility and economic choice to an extent that would otherwise have been unattainable in an area as vast as this continent and, through the secondhand car market, enabled a qualitative "redistribution of wealth" which has been envied even in more centrally planned economies.

The Federal Government may decide that subsidies on an equivalent or greater scale may be required if the use of unconventional sources of energy is, as intended by the plan, to be "vigorously expanded."[10]

If revised and expanded to include a pricing option which discriminates in favor of renewable and recycled fuels so as to rapidly expand their availability and use, the rationale for future energy and investment pricing principles might be phrased along these lines:

> The pricing and investment principles underlying the National Energy Plan include the concept that the prices for oil and natural gas, as for their more abundant but nonrenewable substitutes of coal and uranium, should generally reflect the replacement cost of imported oil.
>
> The subsidies provided for investment in equipment to manufacture or use renewable and recycled fuels, however, should generally reflect within 5 years the full replacement cost of capital needed for these tasks. This should apply to individual users who make such investments and to industrial users and producers of such equipment alike.
>
> Energy users of renewable and other fuels alternative to oil ought to be given incentives equivalent in scope and value to those which were given to producers to explore and develop oil.

With or without generous tax and other business subsidies reflecting privately assumed risks of wartime proportions, large scale Federal procurement may be needed to underwrite an expanded private industrial production capability and to guarantee a continuing market for the new fuel conservation and fuel conversion equipment and facilities needed to make the transition to a less oil dependent age.

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[10] National Energy Plan, p. ix, 31-2 and 75-81.

During World War II and the Korean war, substantial Federal intervention and redirection of private industrial production to meet national security production goals was accepted in large measure because it was conceived of as essentially temporary, "for the duration." There was general agreeement on the wartime goals—defense of democracy, defeat of its foes—but there was also general agreement that, with victory, national production would revert to private hands, its output again determined by civilian consumption choices and needs.

Clearly, a direct analogy cannot be drawn with the present situation. "Victory" will not be "won" by 1985: achievement of the plan's 1985 energy goals would still leave the United States depending on annual imports of about 6 million barrels of oil a day even if these goals could be met—and most analysts conclude that they cannot. However, the accelerated Federal procurement program explored in this paper as an option would not be needed after 1985. Under the assumptions stated in this paper, accelerated replacement of federally owned oil-using capital stock would have been largely achieved by 1985, and thus Federal procurement contracts could then be revert to normal annual replacement levels.

The program could be designed such that, by then, demand in the private sector could and would be expected to drive the process of expanding the volume and scope of the Nation's conversion to the use of fuels other than oil.

A NATIONAL SECURITY ORIENTATION FOR THE NATIONAL ENERGY PLAN

What specific executive and legislative measures could be undertaken more rapidly to convert the Nation's stock of capital plant and equipment by 1985 and to mobilize its industrial productive capacity to meet the national security dangers addressed by the national energy plan?

EXECUTIVE MEASURES

The President and his advisers have already undertaken the first two of the tasks historically assumed by the Executive in situations presenting foreseeable dangers to national security, and many of the rest can be undertaken within the framework of the annual Federal budgets and under existing powers.

Define the nature of the threat to security

The President has identified the nature of the threat and designed a response, in the form of the national energy plan, and the proposed National Energy Act.

Set quantitative targets

The President has set quantitative targets, to be accomplished over a period of about 8 years, intended to meet three "overriding" energy objectives:

1. As an immediate objective that will become even more important in the future, to reduce dependence on foreign oil and vulnerability to supply interruptions;

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2. In the medium term, to keep U.S. [oil] imports sufficiently low to weather the period when world oil production approaches its capacity limitations; and

3. In the long term, to have renewable and essentially inexhaustible sources of energy for sustained economic growth.[11]

Among the specific quantitative goals identified in the plan are the following intended to be achieved by 1985: [12]

4. Establish a Strategic Petroleum Reserve of 1 billion barrels;

5. Reduce gasoline consumption by 10 percent below the 1976 level (6.3 million b/d as compared with the 1976 consumption rate of 7 million b/d);

6. Increase coal production from 1976 output of about 600 million tons to more than 1 billion tons annually, anticipating substitution of coal for oil or natural gas equivalent to 2.2 million b/doe for industrial uses and 1.1 million b/doe for utilities.[13]

7. Insulate 90 percent of the approximately 74 million existing residential units and all new buildings;

8. Install solar energy units in more than 2½ million homes;

9. Limit U.S. oil imports to 5.8 million b/d by 1985.

Place orders for large scale Federal procurement of goods and services

Except for purchases for the Strategic Petroleum Reserves, Federal procurement has not yet been employed on any significant scale to underwrite the capital plant conversion and production efforts required to achieve the quantitative goals of the plan.

The opportunities and authorities for an accelerated exercise of this power exist, however, and could, for example, be used in the following ways:

Synthetic fuels.—Long-term Federal contracts for procurement of oil from shale or other synthetic fuels for Department of Defense uses and stockpiling in the Strategic Petroleum Reserves could be negotiated on a cost basis. Pilot tests using synthetic fuels from coal, shale oil and tar sands have already been conducted under DOD–ERDA financing. DOD consumption of petroleum was 173 million barrels in 1976—about 450,000 barrels per day.

"*Gasahol*".—Federal multiyear contracts for purchase of various forms of nonpetroleum substitutes for gasoline and a Federal commitment to use such substitutes for at least 10 percent of gasoline consumed in federally owned vehicles could be used to guarantee a private sector industrial production capability for these fuels. This would amount to annual purchases of 1.6 million gallons of gasoline substitutes, at 1976 consumption levels.

Electric or other non-gasoline-using vehicles.—As of mid-1976, the Federal Government owned 425,226 motor vehicles, operated at an annual cost of $664.5 million (including depreciation) and using the equivalent of 16 million barrels of oil a year.[14] Excluding buses and ambulances, the Federal Government acquired 19,155 vehicles and disposed of 14,014 in 1976. Public Law 94–163, the Electric and

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[11] National Energy Plan, Overview, p. xi.

[12] Ibid., pp. 83–4 and ff.

[13] Data on anticipated substitution provided in Hearings before the Ad Hoc Committee on Energy, on the NEA, op. cit., Administration testimony and tables, pp. 210–11, submitted in response to questions by Congressman John Dingell, May 12, 1977.

[14] Federal leased vehicles are not included in this total.

Hybrid Vehicle Research Act, mandates Federal purchase or lease of 2,500 electric or hybrid vehicles by mid-1978 and an additional 5,000 by April, 1981, subject to certain conditions. It also calls for introduction of electric and hybrid vehicles into Federal fleets, including the U.S. Postal Service, GSA, DOD, and other agencies "as soon as possible." Incremental costs, as required, including differential operating costs may be underwritten by the ERDA budget. Accelerated and additional purchases would be possible through the annual Federal budget authorization and appropriation process.

Photovoltaic electric power generating panels, also federally procured, could be installed at Federal facilities or at gasoline stations serving Federal fleets, as supplementary battery recharging services for electric vehicles.

Solar heating and cooling and photovoltaic energy systems.—Programs included in the National Energy Act, as tentatively agreed to by both House and Senate conferees, call for installation of solar heating and cooling in about 3,000 Federal buildings in 3 years, at a cost of $100 million, and installation of up to 30 megawatts of photovoltaic energy systems, at a cost of $98 million over 3 years. Both Federal purchase programs were intended to accelerate the commercialization of solar energy and, in the case of photovoltaics, to

> temporarily create, through Government procurement, a large enough market for solar cells so that mass production techniques will be instituted in their manufacture, thus driving down the cost of the cells and consequently stimulating a higher private demand for the solar cells.[15]

Since the Federal Government owns over 400,000 buildings, additional Federal procurement could be used to purchase and install such equipment in many thousands more buildings to expand more rapidly the industrial production capacity of the private sector and to standardize prices and performance criteria for these products. If final action on the National Energy Act is delayed, Federal procurement can be authorized and funded through the annual Federal departmental authorization and appropriations process.

Other Federal procurement orders.—Federal procurement contracts could also be employed to enlarge and underwrite the market for waste recycling, cogeneration systems, wind energy conversion systems environmental protection equipment, fluidized bed combustion devices, and other equipment needed to convert Federal industrial and electric power generating plants from the use of oil and gas to coal, installing them in all facilities now operated by the Federal Government, including the Department of Defense, ERDA laboratories, and the major Federal power administrations—Bonneville, Alaska, Southwestern, and Southeastern.

In a report, "Estimate of National Hydroelectric Power Potential at Existing Dams," published July 20, 1977, the U.S. Army Corps of Engineers concluded that the development of all hydropower potential at existing dams could generate 160 billion Kwh of electricity and save 727,000 barrels of oil per day. Only 5,500 of the 49,500 dams in the United States are owned and operated by the Federal Government. Under a national security rationale, the Federal Government could elect the option of assuming the full capital cost of developing the maximum potential in all other dams as well, whether publicly or privately owned, in order to accelerate the availability of this additional supply.

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[15] Report of the Committee on Energy and Natural Resources, U.S. Senate, on S. 2057, National Energy Conservation Policy Act, S. Rept. 95–409, August 1977, p. 66.

Determine priority access to critical materials and restrict uses when required by national security

Under the Defense Materials System and the Defense Priorities System, the Department of Commerce and the General Services Administration have authority, delegated by the President, to allocate scarce material for production of items deemed essential for national security. This is done under procedures first adopted in World War II, subsequently authorized under the Defense Production Act of 1950, as amended, recently extended through September 30, 1979 by, Public Law 95–37.

These authorities have been invoked for production of equipment needed for the Alaska Pipeline and could be invoked, if needed, for expanded production of capital goods and equipment using renewable and other fuels alternative to oil, such as those suggested in the previous section.

The President also has authority under section 232 of the Trade Expansion Act of 1962, as amended, to limit imports of any commodity upon a finding that such limitation is required to prevent impairment of national security.

In a recent decision involving imposition of oil import fees, the Supreme Court ruled that the President's authority to limit imports for national security reasons included the authority to do so by means of license fees and was not limited to the use of quantitative methods such as quotas.[16]

The President's power to redirect energy uses by quantitative limitation is augmented by powers enacted in EPCA (Public Law 94–163, Section 457) which authorize him to impose direct controls on refinery operations to adjust the proportions of residual fuel oil, gasoline, or any other refined petroleum product if he determines such adjustment is necessary to provide for public health, safety and welfare, and the national defense.

Enlist and mobilize broad public and private sector participation and support

During World War II and the Korean War, a significant component of the high level of popular support for the national defense effort derived from the enlistment of private sector participation in the production planning process, as well as in the production effort.

Although production goals and priorities were set by the executive branch, the pace of production was determined by private industry. The planning procdures and accelerated production pace depended on close consultation and continuing detailed exchange of information on materials requirements and progress of the industrial production efforts at all levels and stages. This close mutual involvement in the planning process helped to produce a sense of national partnership that tended to transcend contractual relationships.

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[16] *Algonquin SNG* vs. *FEA*, U.S. Supreme Court Docket No. 75–382, June 17, 1976. See also Cabinet Task Force on Oil Import Control. The Oil Import Question: A Report of the Relationships of Oil Imports to the National Security, GPO, February 1970, pp. 2–7, and 19–35.

Large-scale Federal procurement in support of quantitative energy goals could also help to mobilize popular participation and support for a national energy plan cast in national security terms. Negotiations on the terms and scheduling of substantial contracts for the production of synthetic fuels and equipment using non-petroleum-based fuels provide both the ends and the means for direct enlistment of the private sector in broader participation in planning for and achieving these national energy goals.

A national industrial production program geared to the achievement of accepted energy goals provides a valid base for national or local campaigns to sell energy production or fuel conversion bonds and stamps to mobilize both extra capital and popular support.

The public market represented by Federal procurement could be substantially broadened by Presidential enlistment of State Governors and county and municipal executives in a similar expanded procurement effort to convert State and local capital plant and equipment in publicly owned and financed facilities and services to renewable and other fuels other than oil.

The overall size and mix of a public market for synthetic fuels, vehicles fueled by alternatives to oil, solar equipment, waste conversion and recycling plants, efficient coal using combustors and environment protection devices, district heating and cogenerating facilities, depends on projected demand. Contracts to meet this demand will require consultation and mutual cooperation between the Federal Government and State and local governments, between the public purchaser and the private producers.

Large-scale Federal procurement orders can provide a clear and unambiguous evidence of Federal commitment to the declared national security energy goals. The planning, contract negotiation, and production processes themselves could be a means, once more, by which a nation and its citizens can be convinced of the seriousness of the threat to national security created by our present dependence on imported oil and, having been convinced, mobilized in its defense.

Maintain the strength of the international collective security system

A threat to national security is by definition a danger that, if not resolved or forestalled, threatens either war or sufficiently massive political or economic disruption that our antagonists need not resort to war to achieve their aims.

It is the latter danger which the President foresees as facing the United States and its industrial allies and seeks to forestall sufficiently to:

> Weather the period when world oil production approaches its capacity limitation; and in the long term to have renewable and essentially inexhaustible sources of energy for sustained economic growth.

The United States presently depends on oil for 47 percent of its total energy needs and is now importing nearly half of all oil consumed in this country. Other industrial democracies are still more vulnerable to supply interruptions: Western Europe depends on oil for 63 percent of its total domestic energy consumption, and imports 97 percent of that oil. Japan is 80 percent dependent on oil and imports all of it.

The volume of physical capital stock of oil-fueled vehicles, heating and cooling systems, industrial boilers, and generating plants which these proportions represent is gigantic. Much of this stock—for Europe and Japan as well as the United States—still has 10 years or more of usefulness. Much of this capital stock must be replaced much earlier by equipment and facilities using fuels other than oil if the security goal of reduced dependence on imported oil is to be achieved by the mid-eighties.

The collective security arrangements which have served to prevent the outbreak of global war have been successful because they were backed by, and negotiated from, a position of military, industrial, and economic strength. A critical element of that strength was the prompt supply of military and industrial goods and equipment transferred in large volume, by aid and trade, to the members of the North Atlantic Alliance by the United States, acting as the "arsenal for democracy."

As the President and the Secretary of Defense pointed out in their testimony, our continued and increasing dependence on imported oil is weakening that industrial and economic strength and is making our military defense increasingly vulnerable as well, placing the whole postwar structure of international security at risk.

Achievement of the U.S. energy goals as stated by President Carter would undoubtedly play a major role in reducing U.S. vulnerability to interruptions in oil import supply but these goals may still leave U.S. allies exposed to unacceptable risks. U.S. security interests may require further expansion of U.S. industrial production capacity and delivery of an additional substantial volume of equipment using non-petroleum-based fuels to enable substantial replacement of our allies' oil-using capital stock earlier than would otherwise occur.

Federal procurement and delivery of such items can be done within the framework of existing collective security agreements and assistance programs. There is also historical precedent for assistance to NATO allies to increase their industrial capacity for equipment essential to collective security and free world strength. During the 1950's, U.S. assistance was provided for a joint military production program financing additional production capacity based in Europe for designated equipment. A similar joint program could be undertaken to accelerate production and use of equipment and facilities using fuels alternatives to oil.

LEGISLATIVE MEASURES

Historically, legislative measures enacted during periods of national security or wartime emergencies have served primarily to support Presidential initiatives and decisions with such additional tax and other authorizations and appropriations as were considered necessary. Any or all of the executive measures outlined in the preceding section could be launched by the President under authorities enacted in laws still in force. Legislative measures could be limited to no more than those required to fulfill such procedures as may be needed to authorize the exercise of some emergency powers,[18] to enact additional tax and other fiscal measures to raise revenues, and to appropriate funds as required to pay for federally procured goods and services or other programs administered by executive departments to meet national energy goals.

However, Congress has the major option of taking much stronger initiatives independently or supplementing executive initiatives in dealing with situations involving risk to national security.

The energy record of the 93d and 94th Congresses, and during the first session of the 95th Congress, provides concrete evidence that the legislative measures Congress may choose to enact by no means constitute passive endorsement of the energy initiatives of three Presidents who have urged early approval of their proposals.

Congress retains, and may wish to exercise, the option to assume a much stronger leading role in the design and rationale of new national policies intended to reduce U.S. dependence on imported oil, and independently to promote Federal procurement and other oil import saving programs which could advance this national security goal.

FEDERAL PROCUREMENT OPPORTUNITIES FOR INCREASING PRIVATE SECTOR INDUSTRIAL PRODUCTION CAPACITY FOR SELECTED OIL-SAVING PRODUCTS

Oil-saving product	Potential Federal market	Potential oil savings
Synthetic oil (oil shale, from coal)	Annual Department of Defense use equals c. 180,000,000 bbl of petroleum (estimated, fiscal year 1978).	Up to 500,000 bbl of oil per day or 180,000,000 bbl of oil per year.
Electric or other non-gasoline-using vehicles.	Federal fleet (worldwide in 1976) equals 425,000 vehicles. Annual new vehicle purchases equals c. 20,000 vehicles.	Depends on degree of replacement of existing fleet: e.g., at 50 percent replacement equals 8,000,000 bbl of oil per year or c. 22,000 bbl of oil per day.
"Gasahol" (ethanol, methanol)	Annual gasoline use by Federal fleet equals 16,000,000 bbl of oil equivalent per year.	Depends on degree of substitution for fuel in remaining gasoline-using cars; e.g., at 20 percent equals 1,600,000 bbl of oil per year.
Photovoltaic and wind energy conversion systems.	400,000 federally owned buildings	Depends on degree of substitution; e.g., photovoltaic devices and solar hot water heaters could be installed in all 400,000 federally owned buildings.
Solar hot water and heating	In 1977, Federal buildings and facilities used 36,600,000 MWh of electricity and 22,000,000 bbl of fuel oil.	
Products which enable oil savings in industrial plants and utilities which burn oil (fluidized bed combustors, environmental protection equipment, cogeneration, district heating equipment, and waste-to-fuel equipment).	Not available at time of writing. DOD has about 55 large boiler plants in the United States which could be converted to coal.	Not available at time of writing.
Incremental hydroelectric power: Turbines and generators.	Federal Government owns only 5,500 of the 49,500 dams in the United States. If Federal procurement were employed to develop all the hydro potential of these 49,500 dams, additional power generated is estimated at about 160,000,000,000 kWh of electricity which equals 727,000 bbl of oil per day.	

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[18] For example, although the President is ordered under EPCA to design and issue regulations for a contingency plan for gasoline rationing, additional formal congressional concurrence is needed before the President may order such a plan to be put into effect (Public Law 94–163, Section 201(c)).

OPEC'S THREAT TO THE WEST

(By Robert Pindyck)*

What kinds of changes should be expected in the prices and availability of world energy supplies during the next 15 years? Will oil prices increase slowly over time, or is another large and sudden price hike likely to be levied by the Organization of Petroleum Exporting Countries (OPEC)? Will energy supplies be available even at higher prices, or should we expect worldwide shortages? And how will these changes in energy prices and availability affect the economies of the industrialized countries?

According to recent projections by the Central Intelligence Agency, a crisis is likely to occur in the early 1980s as world energy demand exceeds supply, resulting in shortages of energy, rapidly rising prices, and economic contraction in all of the industrialized countries. By the early 1990s, the agency believes, the oil shortage will become worse as countries scramble for the scant supply available. This view has had an important role in forming the rationale for the Carter administration's energy program. However, it is a highly unrealistic view, because it ignores the impact of past and future changes in energy prices on energy supply and demand. In fact, this kind of crisis is very unlikely to occur, but another kind of crisis—an oil embargo or OPEC production cutback—could occur quite easily. That prospect needs more attention in the design of U.S. energy policy.

Available data can lead to answers to the questions listed above different from those offered by the CIA. Since the evolution of world energy markets hinges on the OPEC cartel, one may begin by describing OPEC's most likely pricing and production behavior.

This will provide the basis for discussing the kinds of energy crises that should or should not be of concern, and the implications for domestic and international energy policy. Finally, it is appropriate to discuss the likely impact of rising energy costs on economic growth, inflation, and unemployment in the industrialized countries.

OPEC and the Price of Oil

With the power to set the world price of oil, OPEC is a driving force behind world energy markets, and its decisions have profound implications for the economies of all the industrialized countries. It is therefore important to understand the ways in which OPEC is likely to change the price of oil in the future.

OPEC's pricing behavior is surprisingly predictable, since the cartel is most likely to take only those actions that are in its best economic interest. Considerations other than economic ones may, of course, influence OPEC pricing decisions, but economic interests have dominated in the past and are likely to dominate in the future, and they provide the best basis for predicting oil prices. One must therefore put himself in OPEC's position and ask what is the best price to charge for oil.

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What do we mean by the best price? It is often interpreted to mean the price that maximizes profits—or equivalently for OPEC, where production costs are insignificant, the price that maximizes revenue. But a price that maximizes today's revenues, ignoring future revenues, is clearly not "best."

As several OPEC members have already made quite clear, the depletion of existing reserves and its impact on future revenues must also be considered in determining today's price. It makes most sense, then, to adjust the price so that it always maximizes the flow over time of all current and discounted future revenues. Future revenues must be discounted to reflect income lost by not investing current revenues. Just as the stockholders of a company hope that its management will act to maximize the company's equity value (its flow of current and future discounted profits), so too should OPEC determine and set price in a way that maximizes the equity value of its oil reserves.

There are several issues that OPEC must consider in determining its best price. The cartel must recognize that the demand for its oil is, in effect, a residual demand—that is, the difference between the total (non-Communist) world demand for oil and the supply of oil from noncartel countries. This residual demand is particularly sensitive to price; a growing body of statistical evidence indicates that increases in price tend both to decrease total demand and to increase noncartel supply. Of course, the impact of a price change occurs only slowly, since total demand and noncartel supply depend on stocks of energy-consuming and energy-producing capital that cannot be converted or shifted rapidly. This would suggest that OPEC might try to make a quick killing by steeply increasing the price, taking advantage of the fact that the demand for its oil would fall only after a delay of several years. Although such a strategy would certainly increase current revenues, it would diminish future revenues much more, and would therefore be undesirable (unless OPEC members are extremely shortsighted, and there is no evidence to indicate that this is the case).

Another important consideration for OPEC is the fact that its oil resources are finite, and will eventually run out. This has led to speculation that OPEC might sharply increase price and cut production in order to conserve its resources for the future. But overconservation is as bad as underconservation, since it simply reduces the net value of a resource to its owner. OPEC's problem is to exploit its resources in a way that balances revenue obtained today from current production with the discounted revenue that could be obtained from future production. This, in fact, is just the problem facing any producer of an exhaustible resource, and its solution usually calls for smooth and gradual changes in price.

Yet a third problem for OPEC is the fact that its membership is not homogeneous, but instead consists of countries that have somewhat different objectives and operate under different constraints. In particular, some OPEC members—which one might call saver countries—have less immediate need for cash, and therefore could tend to value future revenues more heavily in calculating the equity value of their resources. These saver countries, which include Saudi Arabia, Kuwait, Libya, and the United Arab Emirates, also happen to have rather large reserves of oil, so that resource depletion is less of a constraint on them. Other OPEC members—the spender countries—have a greater immediate need for cash, and thus value current revenues more heavily. These countries, which include Iran, Venezuela, Algeria, Indonesia, Nigeria, and Ecuador, also have much smaller reserves of oil which will begin running out in the next 20 years.

This dichotomy in OPEC's ranks leads to a clear-cut conflict over what is the best pricing strategy. Spender countries would prefer somewhat higher prices than would saver countries, because the spenders prefer larger revenues today, even if that means much smaller revenues five years later as residual demand falls. Part of the internal OPEC bargaining process involves reconciling this conflict. Although the outcome cannot be precisely predicted, there is every reason to expect the interests of the saver countries to dominate, since they (and particularly Saudi Arabia) have the greatest production capacity and at the same time absorb most of the necessary production cutbacks. In fact, the interests of the saver countries dominated after the round of OPEC meetings in December 1976 that resulted in a split price increase: Saudi Arabia simply increased its production slightly, so that the price increase was effectively limited.

What do these three considerations—the way that demand for OPEC oil responds to price changes, the problem of resource exhaustion, and differences in objectives among OPEC members—imply about OPEC's best price? It can be calculated, at least approximately, through the use of a computer model that quantitatively describes the characteristics of total world oil demand (and its response to income growth and price changes), non-OPEC oil supply (and its response to price changes as well as resource depletion), resource depletion within OPEC, and the different levels of reserves and different rates of time discounting among OPEC members. Using such a model to calculate OPEC's current and future best prices, one finds the results to be rather insensitive to assumptions about demand and supply response and the size of the resource base.[1]

The analysis determined that OPEC's best price for 1977 was between $12.50 and $13.00 a barrel—slightly below the actual posted price. Furthermore, in real (constant dollar) terms, this price should grow by no more than 2 per cent per year over the next 10 years. Prices rising more rapidly than this would simply cause a loss of revenue for OPEC, as the resulting loss in sales more than offsets the resulting increase from the higher price. Thus, even allowing for 6 per cent inflation and about a 4 per cent drop in the value of the dollar with respect to all other currencies, OPEC's best price for 1978 is probably about $14.00 or $14.50—close to the current official price.

It is therefore not surprising that the cartel decided at its Caracas meeting in December 1977 to freeze the price of oil postponing consideration of a price increase until June 1978. Although the freeze was explained in terms of a lack of agreement among OPEC's members, in fact it was quite predictable on economic grounds. The disagreement occurred largely because Algeria, Libya, and Iraq wanted a significant price increase—not for economic reasons, but as a political show of force on behalf of the radical element in the Arab world. The price freeze was clearly in the economic interest of Saudi Arabia, Kuwait, and the United Arab Emirates (as well as Libya and Iraq, for that matter), and as long as Saudi Arabia was determined to pursue its economic interests, the outcome was assured.

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[1] The assumptions about supply and demand elasticities used in the model are based on consensus estimates that are consistent with the OECD's Energy Prospects to 1985 (Paris, 1974). The solutions of the model for OPEC's optimal price path are surprisingly robust with respect to these assumptions. For example, doubling the assumed price elasticity of total world oil demands results in less than a 10 per cent change in the optimal price, and virtually no change in the growth rate of the optimal price. The model is described in detail in Robert S. Pindyck, "Gains to Producers from the Cartelization of Exhaustible Resources," Review of Economics and Statistics, to appear May 1978.

What about oil prices in the longer term? OPEC will be meeting regularly and these sessions could indeed result in price increases, but such increases will probably be small. Assuming 5 per cent inflation in the United States and relative stability in the value of the dollar, OPEC should increase prices by no more than 5 or 10 per cent per year. In later years, prices should continue to rise, but again only slowly; around 1 to 3 per cent per year in real terms through 1990, and about 2 to 4 per cent betwen 1990 and 2000. Although the reserves of some spender countries (particularly Iran and Venezuela) will be largely depleted by the 1990s, Saudi Arabia and many of the other saver countries will still enjoy vast reserves well into the twenty-first century.

Of course, it is not certain that OPEC will always pursue its economic objectives rationally, or that it will not at some time pursue noneconomic objectives. Political events—such as another Mideast war, the destruction of oil-producing facilities by terrorists, or the overthrow of one of the key OPEC governments—might lead to a production cutback and a steep increase in price, or, if it results in the dissolution of OPEC itself, a steep decrease in price. It is the possibility of such an event—and only that possibility—that makes U.S. imports of OPEC oil so problematical. Barring such an event, oil prices and their impact on energy markets are surprisingly predictable.

Energy Markets and Energy Crises

The Carter administration has based its energy policy in part on a CIA report that predicts a crisis in which energy demand will exceed energy supply beginning in the early 1980s. According to the report, this crisis will occur because the demand for OPEC oil will grow steadily as world oil demand increases faster than non-OPEC oil supply. OPEC production capacity, on the other hand, will remain fixed or even fall gradually, so that eventually there will be excess demand for OPEC oil. At this point the crisis begins; there is a shortage of oil, and what oil is available is sold at prices that increase dramatically. The result is an induced recession and inflation, very much like what occurred during the embargo and oil price increase of 1974.

The United States certainly needs a coherent and comprehensive energy policy for reasons unrelated to the CIA's concerns, and perhaps the CIA's scenario is useful as a means of mobilizing public opinion to make such an energy policy politically possible.[3] The scenario itself, however, is grossly unrealistic. It essentially ignores two important facts. First, the demand for OPEC oil and (to a lesser extent) OPEC production capacity are highly sensitive to the price of oil. Second, OPEC will gradually and steadily increase the price of oil over time, and at such a rate that capacity constraints will never become binding.

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[3] For a discussion of the domestic aspects of U.S. energy policy, see Robert E. Hall and Robert S. Pindyck, "The Conflicting Goals of National Energy Policy," The Public Interest, Spring 1977.

It is important to recognize that OPEC is now operating well below its production capacity, and that it also has considerable room for expansion in the future. OPEC production in 1977, for example, was about 29 to 30 million barrels per day (mbd), while capacity has been over 35 mbd. How is this figure likely to change in the future? The CIA convincingly predicts that the capacity of such low-reserve countries as Iran and Venezuela will decline during the 1980s as reserves are depleted. The CIA unconvincingly predicts, however, that such high-reserve countries as Saudi Arabia, Kuwait, and the United Arab Emirates will keep their capacity fixed (justified, according to the CIA, by reasons of conservation). In fact, Saudi Arabia and some of her high-reserve neighbors could as much as double their capacity, particularly if there is a revenue incentive to do so. And, as long as these countries are dedicated to pursuing their economic interests, they should increase their capacity, and exploit their oil resources at the optimum price. To do otherwise would be to waste the economic value of their resources.

What can we expect the world oil market to look like, then, in 1985? Given moderate economic growth in the industrialized countries, the demand for oil imports will certainly grow significantly over the next seven years. For all of the countries in the Organization for Economic Cooperation and Development (OECD),[3] total imports from OPEC can easily reach 38 to 40 mbd, as compared to about 26 or 27 mbd in 1975. Adding in OPEC consumption and the oil imports of the less-developed countries, total required OPEC production should be in the range of 43 or 44 mbd.[4] According to estimates of the International Energy Agency (IEA) and estimates constructed at the Massachusetts Institute of Technology, by 1985 total OPEC production capacity will probably have expanded to about 43 to 45 mbd, and that of other exporters to 5 or 6 mbd. Thus there should be no capacity constraint pushing up price, or if prices in consuming countries are held fixed, creating shortages as the CIA report has suggested. The more likely scenario is, as I have argued earlier, slow but steady increases in world oil prices (at an annual rate that is probably not more than 2 or 3 percent in real terms), and perhaps somewhat more rapid growth in wholesale and retail product prices in various consuming countries if stiffer taxes are imposed, or, as in the case of the United States, if existing price controls are removed.

Again, all of this assumes that the OPEC countries pursue their best economic interests, and it is a breakdown in this assumption that would permit a crisis to occur. As discussed earlier, unforeseen political events could indeed result in a sudden change in OPEC production and in the price of oil. If, perhaps as the result of an embargo, OPEC production were suddenly cut back, this could have a seriously disruptive impact on the industrialized economies. But such a crisis could occur as easily next year as in 1985, and it is not this kind of crisis that has been a primary concern of the CIA and the Carter administration.

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[3] Members of the OECD are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[4] This estimate is a modification of the projections made by the International Energy Agency in its publication, World Energy Outlook (Paris: OECD, 1977). The IEA projected about 39 mbd of required OPEC production, but this is based on unrealistically high estimates of installed nuclear capacity in OECD countries. The IEA has recently revised these projections downward.

The possibility of such a crisis should be of greater concern to the administration, however, and it is an important reason for pursuing a domestic energy policy directed at reducing or at least limiting oil imports. Another Arab oil embargo could indeed occur, and the United States, as well as the other industrialized importing countries, should take measures to reduce their potential vulnerability.

For the United States, the most important measure is the development of a strategic oil reserve. The government is now beginning to implement a program that calls for storing oil in underground salt domes near the Gulf coast. The total stockpile would be one billion barrels of oil, which could provide the United States with 6 mbd for six months. Given today's level of imports, this stockpile is probably adequate. However, U.S. imports of Arab oil are growing rapidly, and even if the more important components of the administration's energy program are passed by the Congress, these imports will continue to grow in the future. It is quite likely that by 1981, the United States could be importing 8 mbd from the Arab members of OPEC, and another 4 or 5 mbd from other OPEC and non-OPEC countries. Furthermore, the stockpile is scheduled to reach the one-billion-barrel level only in 1984. In 1981, the stockpile would be only a half-billion barrels, and should an embago occur next year, the United States could expect little relief from the stockpile. If a crisis is really feared, it might be wise to speed up and expand the stockpile program.

Even with a fully implemented stockpile program, the United States would still be vulnerable to an oil embargo. The reason for this, paradoxically, is that an oil embargo cannot really be directed against the United States or any other single country. Oil-producing countries can dictate the quantity of oil to be produced, but they cannot dictate where that oil will ultimately be shipped. For this reason, the announced Arab oil embargo against the United States and the Netherlands in the fall of 1973 had little impact on those countries' imports. Gasoline lines in the United States were really caused by price controls and the misallocation of regional supplies by the Federal Energy Administration (FEA). Although political objectives may be served by claiming that an embargo is directed against a particular country, in reality, an embargo means cutting back production and thereby reducing the oil available to all importing countries.

An embargo that in name was aimed at the United States would, in fact, be just as damaging to the European countries and Japan—more so, in fact, since these countries are more dependent on imports, and lack significant storage programs. Recessions in these countries also place a burden on the United States by causing a reduction in the demand for its exports. Furthermore, the United States is now committed to participate in the sharing arrangement with the IEA. Under this agreement, when an embargo occurs, all of the participating coun-

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tries must share oil (by redirecting oil shipments) in order to equalize the burden of import shortfalls. In fact, if an embargo occurred during the next five years, it would be the United States that would do most of the sharing. Thus, even with a sizable stockpile of its own, the United States is vulnerable to an embargo (production cutback) as long as Europe and Japan are vulnerable.

The European members of the IEA have been chiding the United States for failing to increase domestic energy prices and decrease energy consumption. This criticism is valid; since 1973, energy consumption has fallen by 5 per cent or more in various European countries, while in the United States, where energy prices have been held far below world levels, it has risen by around 5 per cent.[5] On the other hand, the United States should begin to chide the European countries for failing to develop sufficient strategic reserves of oil. Given the realistic limits of the ability of these countries to reduce their use of energy, they will always be heavily dependent on OPEC oil, and always vulnerable to a production cutback. They must therefore develop their own reserves, and thereby reduce the vulnerability of the United States, through the sharing arrangement, to a cutback. If they fail to do so, the United States should reconsider its commitment to the sharing arrangement.

Growth Is No Bargain

It has been argued that the kind of energy crisis of concern to the CIA and the Carter administration is very unlikely to occur, and while energy prices will probably continue to rise over time, the increases will be only gradual. On the other hand, energy prices are already quite high, at least relative to what they were in the 1950s and 1960s. There is no question that higher energy prices have had a significant negative effect on economic growth, unemployment, and inflation in most of the industrialized countries. The question is how these higher prices will affect economic growth in the future.

Higher energy prices have a recessionary impact for two reasons. First, rising energy prices contribute directly to general inflation, and governments often try to fight this added inflation with contractionary macroeconomic policies, such as reduced government spending and slower growth of the money supply, thereby inducing a recession. Second, higher energy prices directly reduce the total productive capacity of the economy. Whenever a particular factor of production—in this case energy—becomes more scarce (that is, more costly), this necessarily reduces the economy's production possibilities. Thus, even if an expansionary monetary and fiscal policy were pursued so that the economy could operate close to its full-capacity level, the resulting GNP would be lower than would be the case if energy prices had not increased.

These phenomena can be illustrated more clearly by considering what happened when energy prices rose dramatically in 1974. First, sharp increases in oil prices contributed directly to increased rates of inflation. In the United States, for example, a good 3 to 4 per cent of 1974's 11 per cent inflation can be directly attributed to the increases in oil prices that occurred that year. Another 1.5 to 2 per cent can be attributed to the higher food prices that resulted from increased demand for wheat and other food exports. This means that only 5 or 6 per cent of the 11 per cent inflation was of the demand-pull variety that the United States is used to, and that is responsive to conventional macroeconomic policy measures. And in Japan and some of the European countries, the inflationary impact of higher oil prices was even greater.

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[5] Providing cheap energy to consumers has been a paramount objective of American energy policy. The main instruments for keeping prices low have been price controls on natural gas and the price controls-entitlements program for crude oil. These programs have caused energy demand to rise much more rapidly than production, and imports to increase to fill the gap. See Robert E. Hall and Robert S. Pindyck, op cit.

The problem occurred when most countries mistakenly responded to this added inflation with strongly contractionary monetary and fiscal policies. The result was sharp recessions in 1975 in the United States, Canada, and most of the European countries. Thus, economic growth from 1974 through 1976 was lower in large part because of misguided macroeconomic policies—policies that might work well against the ordinary demand-pull inflation, but that cannot possibly have an impact on inflation generated from outside the country, as in 1974. In fact, the economic impact of higher oil prices need not have been as serious as it was, had the United States responded with different monetary and fiscal policies.

The second reason for reduced economic growth—the reduction in the total productive capacity of the economy resulting directly from higher energy prices—is more basic, and has broad implications for the future of the industrial economies. The increase in energy prices drove up the total cost of production, and with labor and capital inputs fixed, this meant a drop in real output.

The question now is the extent to which output must fall. The answer depends in part on the extent to which other factors of production may be substituted for energy. If the possibilities for substitution are great, less expensive factors can be used in greater quantity in place of energy. However, recent statistical evidence indicates that energy and labor are substitutable in both the short run and the long run, but that energy and capital are complementary, at least in the short run. There is some evidence that in the long run, energy and capital may also be substitutable, but only weakly so. This means that there is little or no room for a shift toward more capital-intensive production as energy prices increase. Instead, the use of energy and capital will decrease but with little net reduction in cost, since the substitutable alternative—labor—is already very expensive. Thus, the total cost of output is driven up by nearly as much as the percentage increase in the cost of energy times energy's share in total cost.

In the long run, a doubling of the cost of all energy should result in about a 3 per cent increase in the cost of manufacturing output in the United States, a 5 per cent increase in Canada, a 6.5 per cent increase in Japan, and increases in the European countries ranging from 4.5 to 7 per cent.[*] This variation in cost increase is only in small part due to differences in factor substitutability among countries, but is due much more to differences in the existing shares of energy as percentages of total costs.

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[*] These results are reported in Robert S. Pindyck, "Interfuel Substitution and the Industrial Demands for Energy: An International Comparison," MIT Energy Laboratory Working Paper #77-026WP, August 1977.

Assuming that we are correct in our prediction that the sharp jump in energy prices that occurred in 1974 will not be repeated, and that over the next decade energy prices will rise only slowly in real terms, what does this mean for economic growth? Our interest here is in the intermediate term, the next five to eight years, since for the next year or two economic growth will be much more a function of the monetary and fiscal policies adopted in various countries. However, even if most countries adopt sensible macroeconomic policies that push their actual GNPs closer to their "potential" (or full capacity) levels, there is still the question of the extent to which today's higher energy prices will be depressing the level or growth rate of future potential GNP.

For the OECD countries as a whole, average energy prices (aggregating all fuels) have increased more than 100 per cent in real terms since 1972, which means that even in the long run, the total cost of output must rise by at least 5 per cent or so, depending on the particular country. This means a corresponding reduction in real potential GNP. After this reduction has been made, growth can continue at its old rate (4 to 4.5 per cent a year in the United States, and higher or lower rates in other countries). Even with constant energy prices, however, it will be several more years before the United States adjusts to this lower level of potential GNP, and in the interim, actual growth will be reduced.

It is for this reason that many economic forecasters are predicting real GNP growth in the United States of only 3.5 to 3.75 per cent per year over the next five years. This prediction and others like it for Canada and the European countries are quite reasonable, and they mean that even making allowance for a moderate amount of inflation, the industrialized countries will probably face slower growth and higher unemployment rates than they have been used to. There is no way around the fact that by driving up the price of oil, OPEC has made the rest of the world a little poorer.

Reserves Without Reservations

The kind of worldwide energy crisis of concern to the CIA and the Carter administration is unlikely to occur, and, instead, the prices of oil and other fuels are likely to increase slowly over time, thereby limiting the increase in the demand for OPEC oil, and at the same time providing an incentive for certain members of OPEC (particularly Saudi Arabia and the other saver countries) to increase their production capacity during the 1980s. On the other hand, the possibility of a different kind of crisis—a short-term production cutback by the Arab members of OPEC—cannot be ruled out. But even if another crisis never occurs, the increases in oil prices that have taken place already will dampen economic growth and increase unemployment in all of the industrialized countries during the next five to ten years.

This view of the world has important implications for both energy policy and economic policy. In the case of energy policy it means recognizing that the real problem of growing imports is an increased vulnerability to an embargo. Letting energy prices in the United States rise to world levels is important, as it will help considerably to reduce our dependence on imports, and will also permit domestic energy markets to operate efficiently, thereby reducing the total cost of energy in the long run. But even with higher prices, the United States, Europe, and Japan will continue to import OPEC oil. There is no problem with this, as long as steps are taken to limit the vulnerability to an embargo. This is why strategic reserves, not only for the United States but also for the other importing countries, are so important.

In the case of economic policy, it means recognizing that the effects of fiscal and monetary policy will be different in a world where inflation is in part generated by mechanisms outside of our control, and where unemployment is likely to be higher even when the economy is operating near to capacity. If another embargo should occur, the United States and the other industrialized countries should be prepared to respond with expansionary macroeconomic policies. The extra stimulus from such policies will be needed to counteract the adverse short-run effects of an embargo on unemployment and GNP—adverse effects that are much more costly than the temporary burst of inflation that must inevitably accompany an embargo.

The higher unemployment rates that have persisted worldwide since the increase in energy prices are in part due to a greater dependence on capital and energy—at the expense of labor—as inputs to production. This shift occurred gradually between 1950 and 1972 as labor became much more expensive relative to capital and energy. During those two decades, increased energy production worldwide reduced energy's real cost, while tax and social welfare policies in many countries made labor much more expensive relative to capital. Since energy and capital tend to be complementary, the shift away from labor and toward more capital- and energy-intensive production has exacerbated the increased unemployment and reduced GNP that resulted from higher energy prices. Now the industrialized countries must begin to reverse that shift. For the United States this means reworking the fundamental tax structure, reversing the increases in social security and payroll taxes, and perhaps replacing tax credits for investment with credits for employment.

OPEC has made us all poorer, but how much poorer will, in the end, depend on our ability to shift our energy and economic policies. The appropriate changes in policy will help to soften OPEC's impact on us all.

AMERICAN OIL IMPORTS AND WORLD NEEDS

(By John H. Lichtblau)*

The United States is the world's largest oil importer, by far. It is the only major country whose oil imports in 1977 were above the level of 1973. And it is, of course, the single most important customer of the Organization of Petroleum Exporting Countries (OPEC).

These factors have given U.S. oil imports a dominant role in world oil economics. In the future this role could become still more pivotal: If the high end of the range of recent forecasts of U.S. oil import requirements by 1985—14 to 15 million barrels per day—is correct, a world oil shortage in the mid-1980s is a probability. If the low end of the range—6 to 7 million barrels per day—is correct, the world oil surplus could be larger than at present.

It may, therefore, be of interest to analyze briefly the reason for the remarkable increase in U.S. oil imports in recent years as well as their likely future level. But first a few figures to establish a frame of reference.

In 1977, U.S. oil imports of about 8.6 million barrels supplied 46 percent of U.S. oil demand. These imports accounted for about one quarter of total world oil trade (nearly 80 percent of them came directly from OPEC; about 22 percent of OPEC's exports went directly to the United States.)

Between 1973 and 1977 total U.S. oil imports rose by 2.3 million barrels per day or 38 percent, while imports from OPEC alone rose by 3.5 million barrels per day, an increase of more than 100 percent. These increases were of major significance to both oil exporters and other oil importers. For OPEC it has meant that total exports in 1977 were probably fractionally above the previous record of 1973. In the absence of the U.S. import increases, OPEC's oil surplus, i.e. the difference between actual production and allowed maximum production levels, would have been about twice the currently reported size of 2.5 to 3 million barrels per day. Underliftings of OPEC oil of that magnitude would clearly have had some downward effect on prices.

Thus, from OPEC's point of view, the U.S. import increases of 1976 and, particularly, 1977 have been the major factor in containing the current world oil surplus and, hence, supporting the price levels set by OPEC members.

In 1978 U.S. oil imports for consumption will probably show a decline of 350,000 to 450,000 barrels per day from last year, due largely to the onset of full-scale oil production—about 1.2 million barrels per day—in northern Alaska by March and a drawdown in commercial inventories. However, this decline will be largely offset by special imports by the government to build up a U.S. Strategic Petroleum Reserve for emergency use. The latter imports are scheduled to continue at least through 1980.

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*From the Washington Post, Apr. 2, 1978, p. C7. © The Washington Post. John Lichtblau is executive director of the Petroleum Industry Research Foundation in New York. Reprinted by permission.

Imports for consumption will start rising again from about 1979 on, but at a very much reduced rate. From 1977 to 1985 they may grow at 2 percent annually and from 1985 to 1990 at 1 percent annually to reach 10.5 to 10.7 million barrels per day in the latter year. These rates compare with an annual growth of 8.6 percent for the period 1973 to 1977. It is, therefore, likely that the United States will permanently lose its unwanted role of being the pacesetter in the growth in world oil requirements.

The reason for the expected leveling off in the growth in U.S. oil import requirements is a combination of factors: the reaction to higher oil prices, technological improvements in energy utilization, the growth of non-oil energy sources and, perhaps most important, substantially slower economic growth rates than in the last two years.

Take the energy/GNP growth ratio, the so-called energy coefficient, which is considered a very good indicator of a nation's efficiency of energy utilization. For the 20-year period, 1953 to 1973, the ratio was about 1:1. That is, each percentage increase in GNP required a similar percentage increase in energy expenditure. In the last two years (1976–1977) the ratio has declined by one third to about 0.65.

It is not unreasonable to assume that it will remain significantly below the historic level, given the mandated improvement in the fuel efficiency of automobiles, the current boom in the sale of home insulating material and the many announced plans by industrial firms to reduce energy input per unit of output.

In 1976 and 1977 the U.S. GNP grew at 6 percent and almost 5 percent, respectively, pulling energy demand along with it.

In 1978 the growth rate may hover around 4 percent and in the 1980s it will probably average less than 3.5 percent per year. With an expected population increase of less than 1 percent per year and a progressive increase in the average age of the population, this can be considered a normal and politically tolerable development for a mature, highly industrialized economy, resulting in a corresponding deceleration in the growth in energy demand.

Taken together, these developments will not be enough to actually *reduce* the volume of oil imports from the level of 1977 (except for this year). Hence, the administration's announced import goal for 1985 in its National Energy Plan will not be reached or approached.

But market forces plus existing and planned legislation to conserve gasoline demand through improved automobile efficiency, to convert electric utilities from oil and gas to coal and to give preference to coal in new industrial plants are bound to have a significant collective impact on future demand.

Since oil imports are the balancing fuel in U.S. energy supplies, any reduction in the growth rate of total energy requirements will ultimately be translated into lower oil imports. Thus, a scenario under which these imports will grow only very modestly from 1977 on must be considered a realistic one.

D. Prospects for Nuclear Energy and Natural Gas Supply

THE ROLE OF LICENSING IN NUCLEAR PLANT CONSTRUCTION TIMES

(By Carl E. Behrens)*

Introduction

In his April 20 energy speech to the Congress, President Carter said that "as a last resort, we must continue to use increasing amounts of nuclear energy." [1] The National Energy Plan for 1985, released a week later, included 75 new plants "already planned or in construction", in addition to the 63 already licensed to operate.[2]

In connection with his projected role for nuclear power in the national energy system in 1985, the President called for reform of nuclear licensing procedures. Such a reform should include measures to increase safety standards, he said, but he added: "Even with the most thorough safeguards, it should not take 10 years to license a plan." The Administration has distributed for comment several draft bills aimed at revising the nuclear licensing system in line with the President's proposals.

Analysis of nuclear plant construction times and schedules shows, however, that revision of the licensing system would have little effect in assuring that the President's 1985 goal for nuclear power will be met. In addition, such analysis indicates that lengthy construction times are less the result of the present Federal licensing system than they are of uncertainty about expected growth in electrical demand, and of financial difficulties of utilities in obtaining capital to fund expensive nuclear construction projects. Serious licensing delays that have occurred in recent years have been more on the State and local level than through the licensing process carried out by the Nuclear Regulatory Commission, and this trend appears likely to intensify.

Projected Nuclear Capacity in 1985

Although the National Energy Plan indicated that 75 additional nuclear plants "could be in operation" by 1985, the announced schedules of U.S. utilities call for 111 new plants to be in commercial operation by 1985, in addition to those licensed to operate at the beginning of this year. Of those 111 plants, 70 had already completed environmental siting review as well as review of safety and design characteristics, and had received construction permits by mid-1977. Unless new factors are discovered during the construction period which reveal unsuspected safety or environmental effects, these projects would not be expected to encounter further licensing delays.

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*Appeared October 20, 1977. Carl E. Behrens is an analyst in energy policy with the Congressional Research Service, Library of Congress.

[1] U.S. Senate. Committee on Energy and Natural Resources. The President's Energy Program: a Compilation of Documents, p. 12.

[2] Executive Office of the President. The National Energy Plan. April 29, 1977, p. 71.

Proceedings for issuing construction permits on a substantial number of additional plants are well advanced, making it likely that within one or two years the number of plants under construction could be well over the President's goal. In this case, the additional 75 plants called for would be licensed for construction with or without new legislation.

On the other hand, achievement of that goal by 1985 is not certain. A recent CRS study[3] concluded that of the 111 additional plants scheduled to begin commercial operation by the end of 1985, substantial construction has begun on only 57. Delays and deferrals of schedules on the remaining plants appear likely to reduce the amount of nuclear capacity operating by 1985, perhaps below the goal set by the National Energy Plan. As noted above, however, these delays are not likely to be the result of the licensing system, which in most cases is not significant in scheduling once a construction permit is issued. This means that revision of the licensing system would do little to speed up the construction of nucelar power facilities in the 1977–1985 time period.

How Long Does It Take To Build a Nuclear Plant?

The time required to bring a nuclear plant into operation has increased steadily since construction of commercial facilities began in the early 1960's.

Nevertheless, it should not be assumed that the entire time between a utility decision to build a nuclear plant and its commercial operation is consumed by the licensing process. The major licensing activity that is required before construction can begin—the period in which licensing is on the "critical path", as it is referred to—is the safety and environmental review that precedes issuance of a construction permit. Except under unusual circumstances—which have occurred in some cases—it is generally possible for an applicant to obtain an operating license to coincide with the completion of construction.

According to this scenario (See Figure 1), it takes the applicant 18 months to prepare his application and review the environmental aspects of the site he has chosen; it takes the Nuclear Regulatory Commission 12 months to review the environmental statement and issue a Limited Work Authorization, and another 12 months to complete the safety and antitrust review and issue a Construction Permit. During the second 12-month period, site preparation can proceed; another 48 months—during which an operating license is applied for and granted—should see the completion of the plant, with commercial operation following 6 months later, after an initial test and low-power start-up period.

In practice, this schedule has been rarely kept. In some cases licensing has caused delay—for example, following the Calvert Cliffs decision in 1969 requiring the Atomic Energy Commission to prepare environmental impact statements before issuing construction permits, during the start-up of the new Nuclear Regulatory Commission in

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[3] Behrens, Carl E. Projections of Nuclear Generating Capacity, 1985 and 1990. CRS, June 9, 1977.

1975, and other anomalous events. But the major causes of delay in bringing nuclear plants on line since the 1973 oil embargo have been the difficulty utilities have had in obtaining capital to finance construction of plants, and reduction in projected growth of future electric demand. These factors are extraneous to the licensing process.

TIME REQUIRED FROM CONCEPTION TO OPERATION OF NUCLEAR PLANTS
(With Limited Work Authorization Procedure)

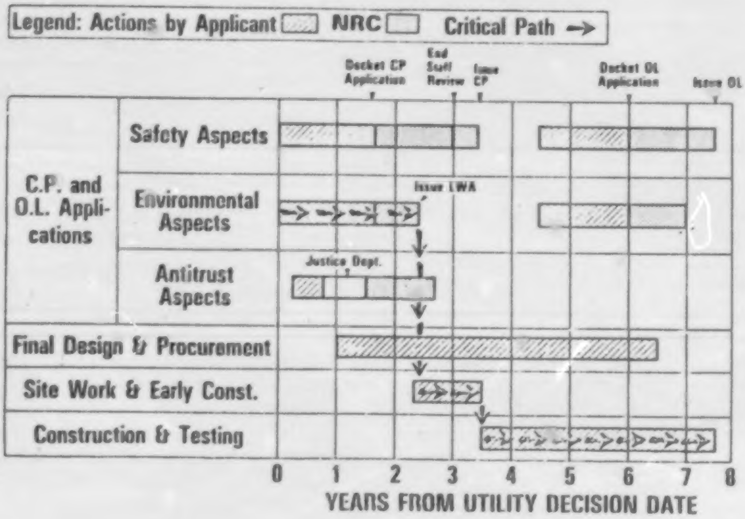

FIGURE 1

Source: Testimony of Lee V. Gossick, U.S. Nuclear Regulatory Commission, before the Joint Committee on Atomic Energy, June 25, 1975.

Construction Times: Historical and Projected

Table 1 gives the average elapsed time, in months, between the dates on which contracts for nuclear reactors were awarded, until the beginning of commercial operation.[4]

These figures indicate that for recent projects the time between ordering a nuclear reactor and projected commercial operation of the plant is close to 11 years. However, as noted above, these times have been subject to deferrals that, in many cases, have resulted from financial decisions or revisions of projected load growth.

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[4] The date on which a contract was awarded for the nuclear steam supply system is probably the firmest starting point for measuring the time required to build a nuclear power plant. ERDA's "Significant Milestones" (See source for Table 1) are arranged in chronological order based on this event. Utilities in some cases announced plans to build a plant before the reactor contract was awarded, but in general little activity has taken place prior to awarding the nuclear reactor contract. With State siting requirements becoming more time-consuming, and NRC review of reactor design possibly becoming more rapid with the advent of standardised design, this situation may change in the future. However, announcement of new plants, and awarding of new contracts, have been so rare in recent years that trends are difficult to determine.

Schedules for 1973 Projects

To gain some indication of the effect of deferrals in construction plans, the nuclear plants ordered in 1973 have been examined in more detail in Table 2. Of the 28 plants ordered that year whose applications have been docketed by NRC, 10 represented multiple units ordered at the same time as the lead unit but scheduled to come on line in subsequent years.

TABLE 1.—AVERAGE ELAPSED TIME BETWEEN AWARDING OF NUCLEAR REACTOR CONTRACT AND COMMERCIAL OPERATION

[In months]

	Number of plants[1]	Average elapsed time	Notes
Year of contract:			
1962-65	10	72	Omits Ft. St. Vrain.
1966	19	84	Omits Diablo Canyon.
1967	19	91	Includes only reactors in commercial operation by September 1977.
1967	30	111	Includes operating reactors and projected operation dates of reactors still under construction.
1968	4	85	Includes only reactors in operation by September 1977.
1968	14	122	Includes operating reactors and projected operation dates of reactors still under construction.
1969	7	141	No operating reactors: projected completion dates used.
1970	13	118	Same note as 1969.
1971	11	134	Same as 1969.
1972	24	131	Do.
1973	28	129	Do.
1974	15	135	Do.

[1] Includes only those plants for which applications have been docketed. No applications have yet been docketed for reactors ordered after 1974.

Source: ERDA. U.S. Central Station Nuclear Electric Generating Units: Significant Milestones. Jan. 1, 1977.

TABLE 2.—PROJECTED TIME BETWEEN AWARDING OF NUCLEAR REACTORS CONTRACT AND COMMERCIAL OPERATION FOR PLANTS ORDERED IN 1973 AND DEFERRALS IN SCHEDULED OPERATIONS

[In months]

Station	Months to operation (present schedule)	Deferral[1]	Months to operation minus deferrals
Clinton 1	101	12	89
Millstone 3	118	42	76
Pebble Springs 1	149	60	89
Perkins 1	141	42	99
Cherokee 1	129	18	111
Jamesport 1	137	41	96
Koshkonong 1	[2] 139	56	83
South Texas 1	87	0	87
WPPSS 3	120	24	96
River Bend	120	27	93
Palo Verde 1	103	13	90
Black Fox 1	112	10	102
Skagit County 1	127	37	90
Callaway 1	108	0	108
Wolf Creek	105	10	95
Tyrone Park 1	129	18	111
Sterling 1	129	18	111
Davis-Besse 2	112	22	90
Average	120	25	95

[1] Difference between present schedule operation date and operation date announced when plant was ordered in 1973. Source: "1973 U.S. Nuclear Power Plant Orders." Nuclear industry, December 1973, p. 39.

[2] In March 1977, applicant abandoned Koshkonong site, chose a new site for the plant, and deferred it another 24 months.

Source: Same as table 1.

If included, those units would artificially extend the contract-to-operation time; for this reason, Table 2 includes only the 18 plants that represent the minimum time as currently scheduled.

From these statistics, it appears that the average time for plants ordered in 1973 is about 10 years, of which about two years represent deferrals from original schedules. In two cases, South Texas 1 and Gallaway 1, no deferrals have yet taken place, and these plants are projected to begin commercial operation in 1980 and 1982, respectively.

Reasons for Deferrals

In general, deferrals in scheduling were attributed to financial restrictions and projected lower load growth. There were exceptions, however. Koshkonong project raised objections from State authorities, and, after long delays, the site was finally abandoned. Both Sterling and Jamesport encountered substantial delays in gaining approval from New York State authorities.

In addition, many utilities when questioned about schedules indicated that, although licensing was not a factor in deferring the schedule, licensing difficulties with other projects indicated that it would have been a delaying factor even if the utility wanted to bring the plant on line on schedule.

Relevance of Licensing Reform

The present licensing system has been sharply criticized in the past by both applicants for permits to build nuclear plants and by intervenors in the licensing procedures who opposed nuclear power. Legislation was introduced in both the 93rd and 94th Congresses to revise the system, and extensive hearings were held by the Joint Committee on Atomic Energy on those legislative proposals. The major thrust of those proposals was to separate the review of environmental effects and site approval from the review of the safety aspects of the design of the plant itself. Some proposals to deal with the question of Federal and State jurisdiction over siting of nuclear plants were also included. Despite the lengthy hearings on the legislation, however, none of these measures was voted on by either chamber.

The current proposals being circulated also include provisions for early site review and consideration of environmental aspects separate from safety and design review. More vigorous measures to deal with the Federal-State review process have also been included in most versions.

In terms of the 1985 goals of the National Energy Plan, however, the analysis above indicates that reform of the licensing system is largely irrelevant. By the time such legislation was passed, and procedures developed for the new site review system incorporated in it, any gains in reduced review time would be felt only for projects scheduled for the late 1980's. or even later.

The role of nuclear power in this later period is shrouded in uncertainty. Several utilities have cancelled plans to build units scheduled for the post-1985 period, partly on grounds that licensing difficulties make reliable scheduling impossible. However, the greater uncertainty lies in the difficulty of projecting future generating capacity requirements so far in advance. In the past utilities have been reluctant to project future loads much beyond five years. In addition, in pre-embargo years construction plans were based on optimistic forecasts of future loads, on the assumption that if demand was lower than projected the excess capacity could be sold through an increased marketing campaign and attraction of new industry to the area. In today's atmosphere of higher construction costs, long lead times for adding new capacity, and emphasis on conservation of energy, such techniques are no longer possible. One of the major obstacles an applicant for a nuclear plant construction permit must overcome, for example, is the requirement to demonstrate that there is a need for the power the project would generate six or eight years hence.

Analysis of recent deferrals in construction schedules indicates that the major factor, besides financial difficulties and load-growth estimates, has been State siting reviews. On the other hand, the development of standardized designs and more efficient review procedures by NRC have always made the Federal licensing system somewhat more predictable. Although some delays and uncertainties have developed—particularly over design for seismic conditions and re-review of operating plants in light of new safety requirements—the Federal system as it stands appears to be improving from a scheduling standpoint. The draft legislation that has been proposed would appear to do little to alleviate such uncertainties.

A procedure for coordinating the roles of State and Federal agencies in reviewing site approval, if effective, could have a positive effect on schedules in the post-1985 period. A large number of nuclear plants are still planned for this period, and decisions on whether to continue or abandon these projects will be influenced in part by the prospects of licensing delays and uncertainties. Thus, licensing reform legislation could have a significant effect on the role of nuclear power in the National energy system in the post-1985 period.

TILTING TOWARD THE NUCLEAR OPTION

(By Joseph Kraft)*

Coal is almost dead. Long live nuclear—and safely. That is the underlying meaning of the marathon coal strike for the country's energy problems. So it is good news that there is being announced this week a new technique that divorces all-out nuclear production from proliferation of nuclear weapons.

For several years now coal has been at the center of the country's energy strategy. Thurston Morton, the top energy man in the last administration, called it "America's ace in the hole." President Carter's National Energy Plan prescribes a substantial increase in coal production by 1985.

But the strike demonstrates that the extensive practice of underground coal mining is not truly consistent with the sensibilities of an advanced industrial—or, as Daniel Bell puts it, a "post-industrial"—society. The work is dangerous, dirty and hard. Those who undertake it demand privileges that go beyond the usual reward of high wages.

The coal miners seek old-fashioned, individual freedom. They don't want to be pushed around by management or labor or government. That is why there is an anarchic union forced by its members to demand the right to have wildcat strikes without any serious penalty against wages, employment or health and pension benefits.

The post-industrial society affords tolerance, if not universal support, for these demands. So the Taft-Hartley law couldn't be made to work, and a seizure of the mines would have encountered—and still might encounter—strong congressional opposition. The president in these circumstances has had as his chief weapon patience, and a prayer that after the operators gave way, the miners would accept their surrender.

Theoretically the problems of eastern coal could have been solved by western coal. For the seams in the Rocky Mountains lie close to the surface and do not require underground mining.

But a feature of the post-industrial society is sensitivity to environmental problems. Another feature is high concern about unemployment.

These two concerns have combined to shape the latest clean-air regulation. The new rules require that 90 percent of the sulfur content be removed from coal before the waste is emitted. That discriminates against western coal, which is so low in sulfur content that it would not ordinarily need any special treatment. As a result western coal will not be competitive east of the Mississippi. There will be no western coal rush.

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*From the Washington Post, February 28, 1978. Washington Insight, by Joseph Kraft, Copyright 1978, Field Enterprises, Inc., Courtesy Field Newspaper Syndicate. Joseph Kraft is a nationally syndicated columnist. Reprinted by permission.

Nuclear power, by contrast, is free from all these social constraints. It is cleaner, cheaper, safer and more reliable than coal. The most progressive power producers in the country have long since gone over to nuclear reactors. A notable example is the TVA, which—having led in hydroelectric power during the 1930s and coal-fired plants in the 1950s—is now going nuclear in a big way.

Association with nuclear weapons, to be sure, has generated a good deal of public apprehension about nuclear power. Though polls and referendums show an overwhelming part of the population favorable to nuclear power, many citizens and political leaders of unquestionably high motivation oppose—and successfully oppose—locating nuclear power plans in major population centers.

But that problem can be met by placing the plants on government reservations or in nuclear parks. Thus the Hanford Nuclear Reservation in central Washington is being used for building three reactors that will provide power to the populous areas around Seattle and Portland. California could also have a piece of that action if Gov. Jerry Brown would be sensible about his state's overwhelming energy difficulties.

A second worry is disposal of nuclear wastes. There has been unquestionable sloppiness in disposing of the nuclear wastes from military programs. Though no damage has been done, some of the radioactive material has leaked from containers stored at Hanford. But that can easily be remedied— and indeed is being remedied—in a crash program for stashing the stuff in new containers.

The problem becomes much smaller if this country begins moving toward reprocessing plants and breeder reactors that use spent fuel to generate more nuclear fuel. President Carter had turned away from that path because reprocessing generates weapons-grade material and thus might promote proliferation of nuclear bombs. His hope was that if the United States went slow, France, Britain, Germany and Japan would follow suit.

They have not—but the delay has yielded a dividend. Scientists in Britain and this country have developed, and are announcing this week, means for going through the whole reprocessing cycle without producing weapons grade material.

That development is a special boon for President Carter, whose past emphasis on nonproliferation was going nowhere. The president would be well advised now to seize the opportunity for proclaiming this country's full entry into the nuclear age.

A BRIEF HISTORY OF NATURAL GAS REGULATION*

Passed in 1938, the Natural Gas Act[1] granted the Federal Power Commission (FPC) power to regulate interstate sales of natural gas for resale. As initially interpreted by the FPC, this meant control of the charges of interstate pipelines selling gas to distribution companies. Only the pipelines' tariffs for transporting gas were regulated; wellhead prices paid to gas producers were excluded, in this early interpretation, by Section 1(b), which states "The provisions of this act . . . shall not apply . . . to the production or gathering of natural gas".

Mainline direct sales to end users of interstate pipelines also were excluded and remain outside FPC purview today. Most local distribution of natural gas is an intrastate activity and falls under the jurisdiction of State public utility commissions.

A piece of New Deal legislation, the Natural Gas Act had as its goal to ensure that consumers paid "fair" prices for gas sold by a natural monopoly (the pipeline industry), which was just beginning to develop at the time of its passage. At that time wellhead prices were extremely low because of the Depression and the fact that the interstate pipeline system, which was the main customer, was in its infancy. In many producing areas, monosonistic situations existed, where single pipeline buyers were able to dictate field prices.

The FPC operated under this interpretation of the Natural Gas Act until 1954, when the Supreme Court ruled in the Phillips[2] case that the FPC indeed had regulatory responsibility for production and gathering. The case arose out of a dispute between Phillips Petroleum, the Wisconsin Public Service Commission (PSC) and the Detroit Corporation Counsel, stemming from a 1945 contract between Phillips and the Michigan-Wisconsin Pipeline. Renegotiation in 1949 raised the wellhead price from 5 cents to 8½ cents per thousand cubic feet (mcf). The contract's inflation adjustment clause was changed so that the price paid to Phillips was tied to the price received by Michigan-Wisconsin from distribution companies at the city gate. In response to complaints by Detroit and the Wisconsin PSC, the FPC scheduled hearings inquiring into the rate's reasonableness. The agenda was then changed, however, to consider only the question of the FPC's jurisdiction.[3] When the Commission refused to take jurisdiction, the Wisconsin PSC brought suit in the D.C. Court of Appeals, which reversed the FPC in May 1953. The Supreme Court upheld the finding that Phillips was indeed a natural gas company within the Act's intent and that its sales in interstate commerce were subject to FPC jurisdiction.

Thereafter, the FPC began to regulate wellhead prices on a producer-by-producer basis. However, congressional action to lift this court-imposed mandate was anticipated. In 1956, Congress passed the Harris-Fulbright Act to do this, but the Act was vetoed by President Eisenhower, who although agreeing with its principles, felt compelled to veto because of "arrogant lobbying" for its passage and allegations of producer vote buying.[4] While other attempts were made to remove producer regulation, none reached the floor of either House of Congress again until 1975.

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*From the Economics of the Natural Gas Controversy, a Staff Study prepared for the use of the Subcommittee on Energy of the Joint Economic Committee, U.S. Congress. September 19, 1977, p. 5–27.

[1] 15 U.S.C. 717.

[2] 347 *U.S.C.* 672, Phillips Petroleum Co. v. Wisconsin (1954).

[3] Clark A. Hawkins, *The Field Price Regulation of Natural Gas*. p. 23.

PRICES UNDER FPC REGULATION

The FPC began to apply to wellhead gas pricing the same regulatory procedures used in electric utility and gas pipeline ratemaking. In practice, however, only 11 full-scale producer rate cases were heard during the 1954–1960 period. All except one (which never was concluded) showed producers' revenues to be less than costs, implying either that oil was cross-subsidizing gas production or that the cost data for gas were exaggerated. In any event, gas production continued to expand. Within the pricing guidelines established by these proceedings, the FPC accepted about 11,000 rate schedules from 3,372 producers between 1954 and 1960.[5] About 33,000 supplements to these schedules had been filed by 1960, and a substantial backlog of cases existed in which rates had been suspended pending hearings.

Due to the hearing backlog, and because of the futility of setting rates which were often above contract prices, the Commission abandoned rate making for individual producers and turned to dealing with broader, geologically homogeneous producing areas. Not only was this challenge intended to consolidate backlogged rate cases, but it would determine fair gas prices based on financial requirements of broad industry segments rather than on individual firms' costs of service. In 1961 the FPC held the Permian Basin Area Rate Hearing, the first of this nature. This proceeding was culminated in 1965 with a ruling which set 16.5 cents per mcf.[6] as the appropriate area rate. A lower price was set for old gas contracted for sale in the interstate market before 1961, establishing a multitiered pricing system based on the vintage of the well. Other area rates were subsequently set, and during the latter 1960s and early 1970s, rates for gas from new wells in the various areas were increased.

Problems stemming from a complex set of different rates for the various producing areas and vintages led the FPC in 1974 to attempt simplification by abandoning the area rate concept in favor of a single nationwide rate. This rate was first set at 42 cents per mcf. For new gas discovered after January 1, 1973. The new gas rate was adjusted to 52 cents per mcf. in 1975, plus an inflation adjustment of one cent per mcf. per year.

On July 27, 1976, the FPC issued Opinion 770, which set a new and radically higher national rate of $1.42 per mcf. for new gas developed after January 1, 1975. The 1973–1974 rate was increased from 52 cents to 93 cents per mcf. (as modified by Opinion 770A in November 1976), and older gas from expiring contracts was allowed to be continued in interstate commerce at 52 cents. All rates are subject to adjustments for

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[4] Robert B. Helms, *Natural Gas Regulation: An Evaluation of F.P.C. Price Controls*, p. 13
[5] Hawkins, *op. cit.*, pp. 77–78.
[6] One mcf. (1000 cubic feet) of gas contains approximately 1,030,000 Btus.

Btu content, State severance tax reimbursement and gathering allowances.

Table 1 shows average gas prices paid to producers under the various ratemaking approaches in current and constant dollars. One observes that the period of individual producer regulation was generally characterized by rising wellhead prices. By 1961, as the area rate approach began to replace producer regulation, prices—especially in constant dollars—began to decline. This decline continued throughout the 1960s. In order to put the decline of real gas prices into the proper context, it is useful to note that unregulated oil prices also tended to decline in constant dollars. This occurred despite government efforts to support oil prices through import quotas and State prorationing.

TABLE 1.—NEW GAS CONTRACT PRICES, 1953-69

Year	New interstate contract price (cents per M ft³)	New contract price in 1958 dollars
1953	13.3	15.1
1954	11.7	13.1
1955	14.4	15.8
1956	14.8	15.7
1957	16.9	17.3
1958	18.6	18.6
1959	18.4	18.1
1960	18.2	17.6
1961	17.9	17.1
1962	17.5	16.5
1963	17.0	15.9
1964	16.2	14.9
1965	17.4	15.7
1966	17.4	15.3
1967	18.6	15.8
1968	19.0	15.5
1969	19.7	15.4

Source: Patricia E. Starratt and Robert M. Spann, "Alternative Strategies for Dealing with the Natural Gas Shortage in the United States," in Edward W. Erickson and Leonard Waverman, eds. "The Energy Question: An International Failure of Policy" (Toronto and Buffalo: University of Toronto Press, 1974, vol. 2, North America, p. 31.

EVALUATING REGULATORY PERFORMANCE, 1954–1972

It is hard to evaluate whether or not the Supreme Court did the correct thing in requiring the FPC to regulate wellhead gas prices. It also is hard to assess whether the FPC responded with the correct regulatory approaches. Critics assert that utility-type regulation was inappropriate for the gas-producing industry, because the gas field operators were highly competitive. Gas production (in contrast with gas distribution) is not a utility-type activity. Those favoring regulation have held, as did the Supreme Court, that such controls were necessary to assure fair prices to consumers, because of alleged market power on the part of gas producers and also because of the presumed bargaining weakness of the pipelines due to their more or less automatic entitlement to pass through their gas procurement costs to customers. In any event, one can assess the extent to which the price set by the FPC deviated from competitive levels by dividing the pre-1970 period into two parts:

(1) During regulation's initial six years, it would appear that the FPC did not hold prices appreciably below market levels. In its early years, indeed, the Commission's role in field markets may have diminished the monopsonistic power exercised by pipe-

lines in some producing areas, resulting in higher prices than would have occurred otherwise.

(2) Some time between 1962 and 1968, the demand for gas (which developed in step with the pipeline system) probably reached a level sufficiently greater than supply for gas prices, had they been unregulated, to have converged to Btu equivalence with oil. This would have meant that industrial users—the first to switch among substitute fuels—would have bid the price up to their oil-fuel equivalent.

During each of these years, industrial sales averaged 35 cents per mcf., of which about 20 cents were for transport and distribution. Wellhead prices averaged less than 15 cents per mcf. (i.e., per million Btus). Industrial bulk fuel users could purchase distillate fuel oil at 15 cents per gallon or roughly $1 per million Btus. Residual fuel averaged about 70 cents per million Btus. Given these oil fuel prices, the potential existed during this period for burner-tip gas prices to rise from 35 cents to between 70 cents and $1. Wellhead prices, therefore, could have risen from an average of 15 cents to between 50 and 80 cents, except where contracts between producers and pipelines prohibited increases.

It is hard to know how contracts signed in the 1940s and 1950s would have been honored in the absence of regulation, as excess supplies of gas disappeared. No doubt many would have been broken or renegotiated. This price boost of 35 cents to 65 cents per mcf., if applied to all flowing gas during the 1960s could have cost consumers between $6.7 and $12.0 billion yearly during the latter 1960s. These sums represent savings which accrued to both intrastate and interstate gas users, inasmuch as interstate prices tended to influence intrastate prices during this period.

Whether or not regulation was useful before 1973, the rise of OPEC placed the matter in an entirely new light. Whether the domestic gas industry is competitive or not is no longer relevant, because all uncontrolled energy prices are under the dominant influence of the OPEC cartel. Until energy supplies are forthcoming in sufficient quantity from non-OPEC sources, competitive prices will not exist. The question is simply whether the U.S. Government or a combination of foreign governments should set prices for domestic energy.

TRENDS IN PRODUCTION AND RESERVES

The natural gas industry grew rapidly in the 1950s and 1960s. Miles of pipeline and main have doubled since the Phillips decision; revenues increased from $3.5 billion in 1954 to $13.0 billion in 1972; and sales rose from 6.7 trillion cubic feet (tcf.) annually to a 1972 high of 17.1 tcf.

Against this backdrop of a seemingly healthy and expanding industry, however, the reported gas reserves underpinning this growth were beginning to shrink. Proven natural gas reserves in the "lower 48" States peaked in 1967. In 1968, production exceeded new discoveries for the first time. Reserve additions in the "lower 48" have never equalled annual consumption again even though production continued to rise until 1973. As Table 2 indicates, reported reserve additions were relatively high from 1954 to 1967, even though constant-dollar prices declined during the latter half of that period. Beginning in 1968, reserve additions dropped off at a remarkable rate, except for the 1970 discovery of the Alaskan North Slope fields. Production from the declining reserve base peaked in 1973 and has declined significantly since that time, although prices have risen by several hundred percent. The contrast between current perceptions of supply possibilities and those of the 1960s, despite the very large intervening price increase, makes it clear that estimates of the Nation's resource base have outweighed price effects in these assessments. A remarkable insensitivity to price is assumed in most current gas supply forecasts. Reasons for this pessimism are discussed more fully below.

As shown in Table 2, however, this drop off in resources is traceable in substantial part to large downward revisions of previously proven reserves, which give rise to suspicions about producer withholding. The section on allegations of withholding appearing below contains further data on this subject.

TABLE 2.—NATURAL GAS PRODUCTION COMPARED TO DISCOVERIES, REVISIONS, AND EXTENSIONS OF PROVEN GAS RESERVES, 1950-75

[In trillions of cubic feet]

Year	Discoveries, revisions, and extensions	Net production
1950	12.0	6.9
1951	16.0	7.9
1952	14.3	8.6
1953	20.3	9.2
1954	9.5	9.4
1955	21.9	10.1
1956	24.7	10.0
1957	20.0	11.4
1958	18.9	11.4
1959	20.6	12.4
1960	13.9	13.0
1961	17.2	13.4
1962	19.5	13.6
1963	18.2	14.5
1964	20.3	15.3
1965	21.3	16.3
1966	20.2	17.5
1967	21.8	18.4
1968	13.7	19.4
1969	8.4	20.7
1970	[1] 37.2	22.0
1971	9.8	22.1
1972	9.6	22.5
1973	6.8	22.6
1974	8.7	21.3
1975	10.5	19.7

[1] Includes Alaska.

Source: AGA Gas Facts, table 4.

EXPERIENCE SINCE 1973

Both actual and potential demand have continued to grow steadily despite an increasing production shortfall. A form of rationing has come into play through the inability of distribution systems and pipelines to add customers and later through formal curtailments of supplies to existing users. Table 3 shows the growth of actual curtailments of "firm" (i.e., contractually uninterruptible) service by interstate pipelines due to inadequate gas production. This method of allocating gas among would-be users clearly involves many inequities and should be replaced, if scarcity persists, with a more rational set of priorities.

With this increasingly painful shortfall, together with OPEC's 1973 oil price revolution, both interstate and intrastate gas prices began to rise. The large increases in FPC nationwide ceilings for interstate gas after 1973 have been chronicled above. In 1974, higher prices became noticeable in the average or "blend" prices paid by interstate pipelines. When the FPC raised rates in 1976 to $1.42 per mcf. plus adjustments, average prices paid by interstate pipelines rose at an accelerated rate.

Shortly after assuming office, President Carter proposed legislation—the Emergency Natural Gas Act of 1977—which addressed the unexpectedly severe gas curtailments of the winter of 1976–1977. This Act, which was passed virtually unamended, contained two major provisions permitting: (i) Federal allocation of gas among interstate pipelines until April 30, 1977, and (ii) purchases by interstate pipelines and industrial users from both producers and intrastate pipelines at prices which "the President determines to be appropriate." Under this law, the FPC authorized emergency sales of less than 0.1 tcf. Prices averaged $2.25 per mcf., except for one sale in excess of $3 per mcf.

TABLE 3.—*Net curtailments of contractually firm interstate gas deliveries, 1972–77*

Period	*Billion cubic feet*
September 1972 to August 1973	1,081
April 1973 to March 1974	1,191
September 1973 to August 1974	1,362
April 1974 to March 1975	2,013
September 1974 to August 1975	2,418
September 1975 to August 1976	2,974
April 1976 to March 1977	3,338
September 1976 to August 1977	3,771

Source: Federal Power Commission.

Although no complete data on intrastate gas prices are available for periods before 1975, Table 4 shows the average prices paid by electric utilities in the gas-producing states. While these prices include some interstate gas as well as relatively small transport charges, they should be indicative of average intrastate wholesale prices. Their rise in the post-embargo era clearly implies an upward trend in intrastate prices for already flowing (old) gas.

To a large extent, however, intrastate gas markets have been protected from nationwide demand by regulation of interstate prices. Producing States—notably Texas and Louisiana—have found large supplies trapped for their use within their borders by prices there higher than in interstate commerce. These prices nonetheless are below those which would prevail in an unregulated national market. Thus, instate prices have been suppressed for a decade or more by the influence of price regulation in the interstate market. This is an often unnoticed, indirect benefit of FPC regulation to intrastate consumers. While such protection still exists, the impact of the 1976 boost in FPC ceilings on prices in the main producing States is becoming observable. Table 5 shows the weighted averages of how prices in new and renegotiated intrastate contracts have increased since the FPC began collecting data.

TRENDS IN DRILLING

Table 6 delineates the trend in drilling activity during the past quarter century. A highlight is the upsurge in gas wells drilled since 1974. Moreover, 1976 was a record year for gas well completions.

TABLE 4.—*Gas prices paid by electric utilities in Texas, Louisiana, Oklahoma, and Kansas, year end*

[In cents per million cubic feet]

Year:	*Price*
1972	27
1973	34
1974	54
1975	83
1976	100

Source: FPC, Form 423.

TABLE 5.—RECENT INTRASTATE WELLHEAD GAS PRICES

[Dollars per Mcf]

	New contracts			Renegotiated or amended contracts		
	High	Weighted average	Low	High	Weighted average	Low
1975 average	2.07	1.20	0.43	2.13	1.42	0.26
January	2.08	1.12	.49	2.17	1.44	.21
February	1.95	1.70	.43	2.07	1.49	.70
March	2.07	1.04	.56	2.08	.76	.25
April	2.04	1.54	.20	1.91	1.67	.25
May	2.04	1.47	.44	2.08	1.46	.19
June	2.12	1.29	.47	2.32	1.58	.20
July	2.08	1.48	.31	2.35	1.52	.26
August	2.30	1.36	.30	2.17	1.06	.44
September	2.14	1.42	.40	2.12	1.53	.25
October	2.03	1.05	.38	2.11	1.51	.13
November	1.94	1.38	.46	2.04	1.74	.37
December	2.16	1.34	.75	2.09	1.32	.38
1976 average	2.08	1.61	.49	2.19	1.64	.49
January	2.00	1.56	.14	2.21	1.84	.25
February	2.13	1.62	.15	2.21	1.70	.26
March	1.90	1.52	.71	2.21	1.62	.45
April	2.16	1.73	.51	2.09	1.22	.18
May	2.01	1.30	.15	2.34	1.83	.16
June	2.04	1.67	.29	2.18	1.71	.49
July	2.17	1.27	.49	2.21	1.15	.20
August	2.03	1.56	.40	2.29	1.60	.80
September	1.87	1.72	.90	2.28	1.95	.97
October	2.12	1.79	.47	2.16	1.58	.48
November	2.00	1.65	1.16	1.90	1.63	.50
December	2.33	1.85	.46	2.17	1.76	1.14
1977 average						
January	2.35	1.81	.15	2.31	1.85	.82
February	1.98	1.66	.42	2.31	1.76	.46
March	2.39	1.91	.44	2.35	1.71	.34

Source: FPC, Bureau of Natural Gas, "Interstate Gas Prices of FPC Jurisdictional Natural Gas Companies Selling More than One Million Mcf. Per Year in Interstate Commerce," FPC form 45, 1975-76.

One can speculate on the reasons why the number of gas wells increased so rapidly between 1972 and 1976. Two reasons could be (i) high profitability of developmental drilling in old fields to convert "old" gas to "new" gas under the FPC's definitions, and (ii) high profitability of new gas sales to the intrastate market at the relatively high new contract prices which prevailed during this period.

The first theory gains credibility from the fact that, while drilling effort increased sharply between 1972 and 1976, the number of dry holes did not increase proportionately. This would imply that producers drilling new wells did so in areas where there was a much higher probability of finding gas—i.e., in old fields. Table 6 shows that drilling activity conformed to this pattern.

Data on the sources of reserve additions also support the theory that much recent drilling has taken place in and around old fields. Table 7 indicates that most new reserves have normally come from revisions and extensions of old fields.

TABLE 6.—DRILLING ACTIVITY IN THE UNITED STATES

Year	Total well completions					Total feet drilled (millions)
	Oil	Gas	Dry	Service	Total	
1957	28, 612	4, 626	20, 893	1, 409	55, 024	233. 1
1958	24, 578	4, 803	19, 043	1, 615	50, 039	198. 2
1959	25, 800	5, 029	19, 265	1, 670	51, 764	209. 2
1960	21, 186	5, 258	17, 574	2, 733	46, 751	190. 7
1961	21, 101	5, 664	17, 106	3, 091	46, 962	192. 1
1962	21, 249	5, 848	16, 682	2, 400	46, 179	198. 6
1963	20, 288	4, 751	16, 347	2, 267	43, 653	184. 4
1964	20, 620	4, 855	17, 488	2, 273	45, 236	189. 9
1965	18, 761	4, 724	16, 025	1, 922	41, 432	181. 5
1966	16, 780	4, 377	15, 227	1, 497	37, 881	166. 0
1967	15, 329	3, 659	13, 246	1, 584	33, 818	144. 7
1968	14, 331	3, 456	12, 812	2, 315	32, 914	149. 3
1969	14, 368	4, 083	13, 736	1, 866	34, 053	160. 9
1970	13, 020	3, 840	11, 260	1, 347	29, 467	142. 4
1971	11, 858	3, 830	10, 163	1, 449	27, 300	128. 3
1972	11, 306	4, 928	11, 057	1, 464	28, 755	138. 4
1973	9, 902	6, 385	10, 305	1, 010	27, 602	138. 9
1974	12, 784	7, 240	11, 674	1, 195	32, 893	153. 8
1975	16, 408	7, 580	13, 247	1, 862	39, 097	178. 5
1976	16, 996	9, 045	13, 690	1, 690	41, 421	185. 2

Source: Independent Petroleum Association of America.

The large price increases for both interstate and intrastate gas, nonetheless, undoubtedly have raised the incentive to find truly new gas reserves as well as to convert old gas to new. The future productivity of these drilling efforts, however, remains to be seen. As Chapter II will show, serious doubts have been raised about the volumes of gas remaining to be discovered within United States territory.

ALLEGATIONS OF WITHHOLDING

There have been numerous allegations involving specific situations in which proven reserves of gas on the Outer Continental Shelf purportedly have been withheld from sale in hopes of higher prices in the future. These allegations involve a refusal to produce out of existing and known reserves dedicated to interstate commerce, not merely under-reporting or failing to report new reserves, which is often considered withholding as well.

Under-reporting or not reporting reserves is the hardest charge to substantiate definitively. Substantiation of the existence of sizable hidden reserves would require examination of vast amounts of geological data and the expertise to evaluate it. Moreover, substantial geophysical testing would be called for to check the data's validity. The FPC has attempted to validate the reserve base, but its study is the subject of some controversy. The FPC examined only a sample of new and old fields. It found reserves in the sampled fields nearly equal to those that had been reported. However, critics express concern about the sample's validity, and contend that new fields, where the most under-reporting is claimed to have occurred, were insufficiently investigated.

TABLE 7.—ANNUAL ESTIMATES OF PROVED NATURAL GAS RESERVES IN THE UNITED STATES, 1965 THROUGH 1976—TOTAL, ALL TYPES

[Millions of cubic feet—14.73 lb/in ^{2}a, at 60° F.]

Year	Changes in reserves during year								
	Revisions	Extensions	New field discoveries	New reservoir discoveries in old fields	Total of discoveries, revisions, and extensions	Net change in underground storage	Production [1]	Proved reserves at end of year	Net change from previous year
1965	[2] 14, 775, 570		[2] 6, 543, 709		21, 319, 279	150, 483	16, 252, 293	286, 468, 923	5, 217, 469
1966	4, 937, 962	9, 224, 745	2, 947, 329	3, 110, 396	30, 220, 432	124, 523	17, 491, 073	289, 332, 805	2, 863, 822
1967	6, 570, 578	9, 538, 584	3, 170, 520	2, 524, 651	21, 804, 333	151, 403	18, 380, 838	292, 907, 703	3, 574, 898
1968	3, 016, 146	7, 758. 821	1, 376, 429	1, 545, 612	13, 697, 008	[3] 118 568	[3] 19, 373, 427	287, 349, 852	(5, 557, 851)
1969	(1, 238, 261)	5, 800, 489	1, 769, 557	2, 043, 219	8, 375, 004	107, 169	20, 723, 190	275, 108. 835	(12, 241, 017)
1970	(99, 721)	6, 158, 168	27, 770, 223	3, 367, 689	37, 196, 359	402, 018	21, 960, 804	290, 746, 408	15, 637, 573
1971	(1, 227, 400)	6, 374, 706	1, 317, 574	3, 360, 541	9, 825, 421	310, 301	22, 076, 512	278, 805, 618	(11, 940, 790)
1972	(1, 077, 791)	6, 153, 683	1, 462, 539	3, 096, 132	9, 634, 563	155, 563	22, 511. 898	266, 084, 846	(12, 720, 772)
1973	(3, 474, 756	6, 177, 286	2, 152, 151	1, 970, 368	6, 825, 049	(354, 282)	22, 605, 406	249, 950, 207	(16, 134, 639)
1974	(1, 333, 285)	5, 847, 251	2, 013, 745	2, 151, 473	8, 679, 184	(178, 424)	21, 318, 470	237, 132, 497	(12, 817, 710)
1975	383, 449	6, 027, 433	2, 423, 382	1, 649, 424	10, 483, 688	302, 561	19, 718, 570	228, 200, 176	(8, 932, 321)
1976	(1, 197, 119)	5, 337, 707	1, 421, 013	1, 993, 867	7, 555, 468	(187, 550)	19, 542, 020	216, 026, 074	(12, 174, 102)

[1] Preliminary net production.

[2] Separation of revisions from extensions of new field discoveries from new reservoir discoveries in old fields not available prior to 1966.

[3] This value has been changed to correct a numerical error made in vol. 23.

Source: American Petroleum Institute, "Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada as of December 31, 1976."

Note: Figures in parentheses denote negative volume.

One of the more important sources of suspicion regarding withholding is the downward revision of old fields' reserves. These reserves are largely dedicated to the interstate market. Table 8 contains data on selected fields and producing areas. Dates of discovery show that most of these fields are old and must have well-known geology. Typically, old fields have low production rates as well, yet large declines in reserves were recorded during short periods of the past decade. It should be noted that the revisions are net figures that take account of reserves added as well as downward revisions. The downward revisions in prexisting reserves, therefore, are substantially larger than the net figures show. Thus, for example, a decline of 2tcf. in Texas District 3 shown in Table 8 appears to indicate an extraordinary drop in the reserve data.

In any event, it is clear that incentives to withhold production of interstate gas have been quite strong since the early 1970s. It is very difficult to believe that producers have not responded to this incentive, at least in the many cases where no legal obligation prevented their doing so.

TABLE 8.—AMERICAN GAS ASSOCIATION ESTIMATES OF ULTIMATE RECOVERY OF NATURAL GAS, BILLION CUBIC FEET (BCF), SELECTED YEARS OF RESERVOIR DISCOVERIES AND ESTIMATES

	Years			Estimates (BCF)	
	Discovery	From	Through	From	To
A. NONASSOCIATED					
Texas:					
District 1	1953	1370	1974	390.4	206.0
District 2	1963	1967	1970	430.2	187.1
District 3	1935	1970	1973	5,869.5	3,828.3
District 4	1940	1970	1375	1,504.4	854.5
District 7B	1929	1966	1967	74.0	7.4
District 7C	1965	1969	1971	694.1	365.8
District 9	1950	1968	1969	2,442.7	2,204.7
Louisiana:					
North	1927	1966	1967	647.1	.4
South	1959	1969	1973	5,391.4	593.3
B. ASSOCIATED-DISSOLVED					
Texas:					
District 3	1929	1966	1974	543.7	82.0
District 4	1939	1970	1975	1,714.4	1,147.6
District 5	1933	1969	1970	192.0	142.0
District 6	1930	1967	1974	1,958.1	1,414.5
District 8	1949	1966	1968	1,509.1	76.5
Louisiana: South	1937	1969	1975	2,939.3	1,925.3

Source: Tabulations prepared by Joseph Lerner from "Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas * * *," American Petroleum Institute & American Gas Association, various editions.

FUTURE GAS PRICES UNDER EXISTING REGULATIONS

Interstate prices, now averaging nearly 60 cents per mcf., will converge in time on the $1.42 rate, plus adjustments, applicable for new gas. How long this convergence will take is hard to estimate. Between January 1973 and August 1976, average interstate prices rose by 133 percent from 24 cents per mcf. to 56 cents per mcf. During the 1½ years when the 42- to 52-cent price ceiling prevailed, producers had found ways to increase average prices, including adjustments, up to the then current new gas ceilings. With constant readjustments of old gas prices, which the FPC has provided, substantial price rises already are programmed into the system.

It would appear, therefore, that average interstate gas prices will converge toward $1.50 per mcf. within several years even without any changes in present regulatory procedures and without any new increases in the FPC's national ceilings. Such price rises will cost gas users over $10 billion per year for today's volume of gas deliveries.

THE CASE FOR DEREGULATION OF NATURAL GAS*

Obviously the current system of price fixing is not working. Some would prescribe a larger dose of the same—FPC control of intrastate gas prices coupled, no doubt, with an allocation system to ration remaining supplies. We submit that deregulation is in order for the following reasons:

In the long run, and quite possibly in the short run gas prices to the consumer will be lower with deregulation.

Deregulation will stimulate the finding of more reserves and increase production.

Deregulation will lessen our dependence on foreign sources.

Deregulation will allow consumers in nonproducing states an opportunity to secure new gas supplies.

Deregulation will stimulate development of alternate fuels.

Deregulation will help the environment.

Deregulation will encourage conservation.

Regulation of wellhead gas price is unnecessary because the gas industry is competitive.

Regulation of wellhead price is administratively impossible.

Regulation of wellhead price is unfair.

LOWER PRICES

The primary purpose behind the regulation of wellhead prices of natural gas is to keep the price of natural gas at the lowest price possible for the consumer. Ultimately, regulation of natural prices could result in exactly the opposite effect as explained in the following bit of testimony

> We recognize that many are concerned about the effect of deregulation on prices. In fact, the price impact on the consumer will not be significant with new gas deregulation . . . with continued regulation, gas curtailments will rapidly become much more serious, and the transmission costs per unit of delivered gas will escalate. Last year's experience with rising prices and gas curtailments strongly suggest that the costs of continued regulation might well exceed that of deregulation. In addition, supplemental supplies to replace domestic gas could raise consumer prices higher than deregulated gas. Foreign LNG and SNG from coal or petroleum would add several dollars to the purchaser's price.
>
> The deregulation of new natural gas would allow the average wellhead price to increase more rapidly than under continued regulation. However, the effect on natural gas prices paid by the residential customer would be small and gradual for two reasons. First, interstate gas is sold under contracts of 15 to 20 years. In 1975, only about 8 percent of these contracts would be negotiable at the new deregulated price. By 1980, the proportion of new contracts would still be only 40 percent.
>
> A second reason for the gradual impact is that less than one-fifth of the residential price can be attributed to the price in the gas field. This means that the 6¢ per Mcf increase due to deregulation in 1975 is only 4 percent of the total

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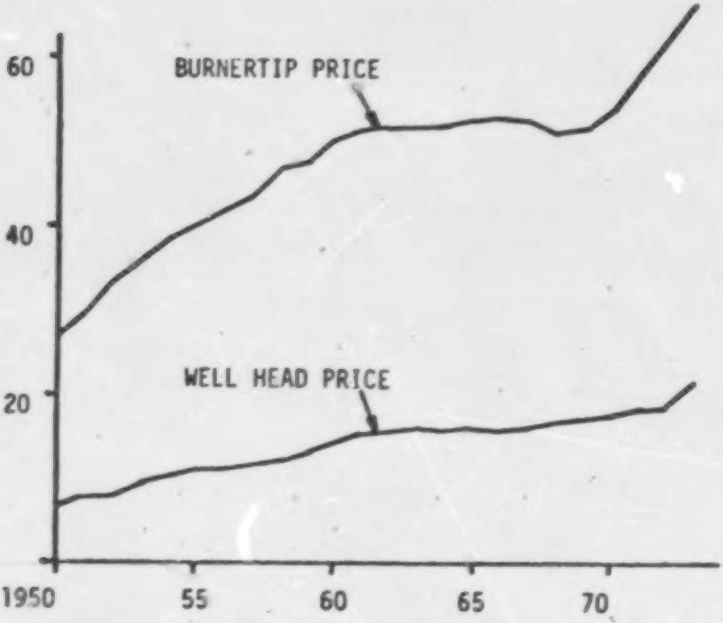
*From Natural Gas: A Case for Decontrol Prepared by the Governor's Energy Advisory Council of Texas, 7703 N. Lamar Boulevard, Austin, Texas 78752. July 1976. p. 15–25.

residential price under continued regulation. If price controls on new natural gas were lifted in 1975, preliminary FEA estimates show that the impact on the average annual residential bill would be $10.21 in 1976, $13.30 in 1977, and $19.15 in 1978. The percentage increase for those years are 6.2, 8.0, and 11.5. Higher gas prices potentially increase the prices of a number of other goods and services. However, the overall effect on the Consumer Price Index and the Wholesale Price Index is expected to be minimal.

If new gas prices for gas sold interstate are not deregulated, the effect on the Nation will be extremely serious and deleterious to the achievement of critical national goals.

NATURAL GAS PRICES
(¢'s/MCF)



In addition, an end to regulation will lower producer costs and benefit the consumer/taxpayer by reducing or eliminating a significant expense due solely to the regulatory process—support of a large bureaucracy, legal fees, court costs, red tape, and a diversion of company time and managerial talent away from expanding production. In the end, the consumer and taxpayer must bear these burdens through higher prices and/or taxes.

INCREASED SEARCH

In 1973, the Potential Gas Committee of the American Gas Association estimated that the potential remaining natural gas supplies in the U.S. amount to 1,146 trillion cubic feet (tcf).[1] Together with the nation's proved reserves of 228 tcf at the end of 1975,[2] this supply would last about 60 years at present production rates—enough time to tide us over until alternate energy sources can be developed on a large scale.

However, it is vital to distinguish between a resource estimate with a 50-year supply and a reserve of only 10 years supply.

For the resource to be translated into a reserve the gas deposits must be located through exploration. This exploration simply will not occur until there is the incentive of higher prices—or until the expected net returns from such exploration is at least equal to the next best alternative for investment capital. In short, gas which might be economically recoverable at $2 per Mcf will not be recoverable with a price of 50¢ per Mcf.

Sixty percent of the potential remaining supplies estimated by the Potential Gas Committee are either offshore, deeper than 15,000 feet or in Alaska. These are very high-risk, high-cost ventures.

That producers will respond rapidly to relief from FPC regulation is indicated by a doubling of new gas wells drilled in the Texas Panhandle between 1971 and 1972 following the approval by the FPC in 1971 of an indirect deregulation of certain small producers.[3]

Under current conditions, the FPC predicts a shortfall between supply and demand on interstate lines totaling 3.6 trillion cubic feet (tcf) for the period April 1976–March 1977. This compares with a shortfall of 2.8 tcf over the previous year. A shortfall will cause more industrial shutdowns, layoffs and, on some lines, could effect home deliveries. However, this is only the beginning. A recent study by Professor Paul MacAvoy and Robert S. Pindyck of MIT shows that under FPC regulation the shortfall will range between 8 to 12 tcf by 1980. The study also indicates that phased deregulation could reduce the shortfall to negligible levels by 1980.[4]

To continue FPC regulation in the light of such evidence is *not* in the interest of American consumers.

FOREIGN DEPENDENCE

By early 1976, the U.S. was dependent on foreign countries for approximately 42 percent of our oil demand and about 4 percent of our natural gas demand.

If deregulation of natural gas does not occur, domestic gas production will continue to decrease. The resulting shortages will have to be alleviated by importing more oil, by importing expensive liquified natural gas (LNG) from overseas, or by producing so called synthetic natural gas from coal or petroleum. To make matters worse, Canada has already warned the U.S. that it intends to phaseout by

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[1] The Potential Gas Committee is composed of 150 eminent geologists and petroleum engineers directed by the Colorado School of Mines. Their estimate of 1,146 tcf is one of several estimates by various groups. Some of the estimates are considerably higher. Recently, however, lower estimates of recoverable gas supplies have been forthcoming from equally qualified groups such as the National Academy of Sciences. NAS estimates our total "undiscovered gas reserve" to be 530 tcf—a 25 year supply at current production rates.

[2] Committee on Natural Gas Reserves, American Gas Association. 1975.

[3] Remarks by Senator Lloyd Bentsen, *Congressional Record*, June 12, 1975, pp. S10457–59.

[4] *Ibid.*

1980 existing gas exports to the U.S. These imports currently account for about 4 percent of our supply.[5]

Increased imports of oil from OPEC nations will further impact our balance-of-payments situation and increase our vulnerability to foreign nations. The substitution of LNG or SNG at prices estimated to exceed $3/Mcf is indeed a strange way to combat increasing gas prices.[6]

NEW SUPPLIES

Virtually all of the shortfall between supply and demand has been borne by the customers of the interstate market. The reason is simple. Producers of newly discovered gas are marketing most of their product on the intrastate market where prices are as great as four times the ceiling imposed by the Federal Power Commission.

In 1970, 69 percent of the new gas supplies were sold in the intrastate market. By 1973 some 83 percent of the new gas was committed to the intrastate market.[7]

By virtue of the unrealistically low ceilings imposed on gas prices by the FPC, interstate consumers are denied the opportunity to bid for these new supplies and thus alleviate the shortage which is almost entirely confined to the interstate market.

ALTERNATE FUELS

Currently, the U.S. relies on oil for about 46 percent of its energy and on natural gas for about 32 percent while coal accounts for only about 17 percent. At current rates of consumption oil and gas proved reserves will last only about 10 years while coal reserves will last 800 years.[8] Obviously, the U.S. must reverse this dependence on oil and gas by shifting to the development of alternate sources.

This switch will be retarded as long as the Federal Government continues to hold the price of natural gas far below the equivalent energy prices of other sources. The following table illustrates the fact that the underpricing of natural gas compared to other fuels is severe and growing worse. These FPC figures are for delivered fuels to electric power plants based on the average cents-per-million BTU's of energy.

AVERAGE DELIVERED FOSSIL FUEL PRICES

[Cents per million Btu]

Fuel type	January 1973	December 1975
Coal	37.8	82.2
Oil	67.0	201.1
Gas	29.9	86.1

Since natural gas is by far the cleanest, least abundant and most convenient of the three fossil fuels used by the electric power industry, one would expect this premium fuel to be the highest priced. Instead, it is approximately equal the price of coal and less than one-half the cost of fuel oil. In the intrastate market, however, the price of natural gas is approaching the price of the next best alternative—fuel oil, and has passed the price of coal.

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[5] FPC News Vol. 8 #23.

[6] 1976 *National Energy Outlook* (FEA), p. 157.

[7] "FPC Warns of Worsening Gas Shortage", *The Oil and Gas Journal*, Jan. 13, 1975, p. 29.

[8] Project Independence, A Summary, Federal Energy Administration, November, 1974. p. 17.

The nation's coal production facilities and our coal conversion technology (gasification and liquification) would be much more developed at the present if the federal government had not undercut the coal market by holding down the price of gas.

By deregulating natural gas prices at the wellhead, two things will occur which will insure a more orderly transition away from oil and gas to other fuels:

(1) The producers and marketers of alternate fuels and energy sources will proceed with development without fear that the market for their product will be destroyed by arbitrary regulatory actions.

(2) Natural gas producers will discover and produce more gas thus buying more time for an efficient and orderly transition to alternate fuels.

The alternative is that for the next few years consumers will continue to use natural gas because of its relative low price. Meanwhile, the development of alternate energy sources will be discouraged. As reserves approach depletion, the nation will find itself in a seemingly unresolvable dilemma, very short of gas but without the lead time necessary to develop and market alternate sources. In short, deregulation will stimulate a greater supply of total energy by increasing gas supplies and hastening development of alternate fuels.

CONSERVATION

Decreasing the demand for energy is just as important in solving the energy crisis as is increasing supply. Deregulating gas prices will contribute to decreasing demand by permitting natural gas prices to reflect its market value as a fuel.

Between 1960 and 1974 U.S. gross energy consumption increased at an annual rate of 3.6 percent. However, because natural gas prices were artificially suppressed by FPC regulation, demand for natural gas increased at an annual rate of 4.1 percent.[9]

Had natural gas prices not been controlled at artificially low levels, demand would not have been over stimulated. Builders would have installed adequate insulation in homes and manufacturers would have found it more economical to replace old industrial equipment with more efficient processes. Because it was cheap, it was wasted. Scores of economic analyses show that when a product is not allowed to reflect its market value it will be misallocated. Regulation of natural gas prices by the FPC has caused overuse of our cleanest and most valuable energy source as compared with the use levels under free market conditions.

Deregulation of natural gas prices will also help conserve energy by making more efficient use of primary fuels. When natural gas is produced from the ground it needs very little processing to be usable in the home or factory. All other fuels must undergo considerable refining, alteration or conversion before they are usable. In the process, much of their original energy content is lost. In converting coal to gas up to one-third of the available energy is lost. The refining of crude oil requires about 10 percent of the energy of the oil refined, and for every BTU of electricity generated some three BTU's of fossil fuels must be burned. The conversion and utilization of uranium ore by present facilities is only about 1 percent efficient.

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[9] *Energy Perspectives*, Dept. of Interior, February, 1975, p. 36.

By deregulating gas prices, greater supplies of this energy-efficient fuel will be made available.

ENVIRONMENT

If natural gas prices are not deregulated and gas supplies continue to dwindle, the environment will suffer. Without deregulation much of our undiscovered natural gas resource may never be recovered and used.

There is no question that gas is the cleanest fuel available at present. To extract it, only a few holes need to be drilled—no strip mining, no oil spills, no radiation contamination. The facilities needed to process and transport the product are already in place in the nation's gas producing areas. It needs no refining or smelting. Most of all, gas is environmentally superior when it is consumed. It is clean burning—no residue, no ashes, no air pollution.

COMPETITION

A major reason given for continued regulation of gas producers by the FPC is the charge that gas producers are monopolistic, or at least so concentrated that the industry is not competitive.

There are approximately 10,000 oil and gas producers of which some 3,700 supply natural gas to interstate pipelines. The number of producers is an indication that the industry is not monopolistic and that there are no overly-restrictive barriers to entry in the market (outside of FPC regulation).[10]

It is true that compared to the total number of producers, a relatively few companies produce most of the gas. An FPC study shows that in 1971, the nine largest producers accounted for just under 50 percent of the total of gas sales to pipelines while the top 20 producers accounted for 70 percent of the market.[11]

Yet, this degree of concentration is far less than that of many non-price-controlled industries such as automobiles and steel. In fact, the Census of Manufacturers shows that most of the 412 industries surveyed have concentration ratios higher than that of the natural gas production industry.[12] This evidence suggests that the natural gas industry is more competitive than half of American industries.

Another misconception about the gas producing industry is that it is vertically integrated (i.e. the same companies that produce, also transport and sell the gas). FPC chairman John Nassikas testified before a Senate Commerce Committee subcommittee in October 1973 that vertical integration in the gas industry is minimal. He noted that 13 of the 31 major interstate pipelines purchase their entire supply from independents or other pipelines. Of the remaining 18 lines, 16 buy at least 80 percent of their supplies from other lines or independents. The other two lines rely on affiliates or company-owned production for less than half of their supplies.

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[10] Vol. 1, Chapter 3. *National Gas Survey*, F.P.C., 1975. p. 8.

[11] *Ibid*. p. 9–10.

[12] "The Natural Gas Industry Hearing Before the Subcommittee on Antitrust and Monopoly of the Committee on the Judiciary, U.S. Senate", 93rd Congress. Part 1 (June 1973) p. 361.

Finally, even if the gas industry were noncompetitive and vertically integrated, the competition factor would express itself in the form of interfuel price competition. There is evidence that in Texas, the nation's primary intrastate market, price increases for new gas leveled off in 1975 as it approached $2 per Mcf. Based on an equivalent energy basis, this was approximately the same for new (or uncontrolled) oil.

ADMINISTRATION

By virtue of the 1954 Supreme Court *Phillips* decision, the FPC has been required to regulate the nation's several thousand gas producers just as if they were a relatively small group of monopolistic utilities. This regulation is based on the cost-of-service concept. However, by the FPC's own admission "current and prospective real costs" cannot be determined.[13]

Evidence that cost determinations are largely arbitrary and capricious came forth last year when the FPC determined in June, 1974 that producer costs satisfied a national price ceiling of 42¢ per Mcf. However, in December, 1974, using the same evidence, FPC determined a "cost" of 50¢ per Mcf.

Why is it that the cost-of-service technique, which works reasonably well with monopolistic utilities, is impossible to administer for gas producers?

First, there are a large number of producers to be regulated. According to the FPC, there were 3,750 regulated producers in 1971.

Second, the cost-of-service approach is not appropriate for gas regulation because oil and gas are joint products discovered together in various proportions. Since the cost of the well is mostly a joint cost, no formula has been devised which accurately allocates costs to oil and gas separately.

In the process of discovery, one wildcat well in seven discovers economically-recoverable hydrocarbons. Therefore, the dry-hole costs must be appropriately allocated to a few successful wells, and this, in turn, allocated between oil and gas. The gas itself must be further subdivided between dry gas (for the interstate market) and natural gas liquids. Even if these costs could be determined for each successful well an even more difficult problem arises in the potentially great variation between the amount of reserves uncovered by any two wells. If a well discovers a huge reserve, its cost per unit of gas discovered is low for rate-making purposes. This regulatory approach penalizes efficiency and rewards high-cost ventures finding relatively little gas.

This is the basic flaw in cost-of-service regulation as far as the consumer is concerned. It provides little incentive for efficiency. It is a necessary evil when regulating monopolies. However, cost-of-service regulation provides no counter balancing benefit to the consumer when a competitive industry is regulated.

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[13] FPC Opinion No. 595, Texas Gulf Coast Area Rate Proceeding, May 6, 1971, Vol. 45, FPC Reports, p. 667.

FAIRNESS

Even if it were possible to arrive at a formula which would accurately determine the producer's costs-of-service, the imposition of this formula on a competitive industry is unfair. Other industries—many of which are dominated by a handful of large corporations (autos, steel, etc.)—are free from this form of regulation.

The best evidence that the cost-of-service approach has been unfair in the past is the contrast between producer drilling costs with gas prices. Either through regulatory lag or an indifference to the producer's plight, the price of interstate gas was allowed to rise at only half the rate of drilling costs. For the decade 1961–1971, the average price of gas sold to interstate pipelines has increased by 24 percent while the average gas well drilling costs per foot have increased by 57 percent.

One of the largely unspoken reasons that oil and gas deregulation legislation is having difficulty securing passage is the emotionally powerful argument that petroleum is a national resource and that a few producing areas of the Nation should not be allowed to prosper at the expense of the great majority of the country's consuming areas. Such thinking is behind the legislative effort to inflict intrastate controls on natural gas. Off-the-record comments such as "Texas and Louisiana residents are profiting from an accident of geography," often precede confiscatory action by a federal government overwhelmingly dominated by consuming states.

Other areas are endowed with equally accidental geographical features. Pennsylvania has coal; the Pacific Northwest enjoys very low electricity rates because of cheap hydroelectricity; Iowa can produce food cheaply and abundantly because of soil and climate conditions; Floridians profit by not having to spend as much of their income on heating, winter clothing or beach vacations . . . the list is endless.

The point is that it would be unthinkable to force residents of these areas to subsidize less fortunate areas on the basis of geographical endowments.

In short, it is clearly unfair to treat some areas of the Nation as producing colonies simply because it is technically feasible to extract and transport their resources and politically possible to outvote their representatives.

THE CASE FOR CONTINUING REGULATIONS*

THE NATURAL GAS PRODUCER MARKET IS MONOPOLISTIC

1. Most natural gas reserves are controlled by a few large, multinational oil companies. These companies engage in numerous joint ventures with smaller companies, with their pipeline customers, *and* with each other. Many economists have concluded and the Federal Courts have affirmed that *the natural gas producer market is not competitive!*

2. Most consumers of natural gas are unable to switch to other fuels. Thus, *deregulation would force them to pay higher prices—which would be set in a non-competitive market at monopolistic and artificially high prices!*

THE NATURAL GAS "SHORTAGE" IS BASED ON BIASED DATA

3. Gas producers say there is a natural gas shortage. This claim is based on reports of the American Gas Association's Reserve Committee—a commitee dominated by the gas producers. The Federal Power Commission, the Federal Trade Commission, the Courts and numerous Congressional Committees have concluded that the AGA reserve data is unreliable, inconsistent, biased and subject to manipulation.

4. Since the AGA reserve data cannot be trusted, the producers must supply the government with their own reserve data which can be audited and verified. Seven out of eleven producers, however, refused to comply with an FTC subpoena seeking such information. Twenty producers have challenged the FPC's authority to collect reservoir by reservoir and intrastate reserve information under the FPC's new Form 40.

THERE IS NO NATURAL GAS SHORTAGE

5. There have been no serious shortages of natural gas this winter despite the warnings of the Federal Energy Administration and the Federal Power Commission. Even the producers admit that there are plenty of reserves of natural gas still to be discovered.

6. Producers have shut in wells, delayed development, diverted supplies into the unregulated intrastate markets, and have not complied fully with the delivery terms in their contracts. Shortages have occurred because producers have deliberately acted to deprive the interstate market of supplies. And the interstate pipelines have failed to act on behalf of their customers by not taking legal action against the producers.

7. Producers are diverting supplies from the interstate market. They are selling new gas in the intrastate market at substantially higher prices.

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*From Natural Gas Factbook. Prepared by Energy Action Committee, American Public Gas Association, Energy Policy Task Force. p. 1–3.

THE FPC PROVIDES PRODUCERS WITH GENEROUS INCENTIVES

8. Producers claim they have no incentive to sell gas in the interstate market at regulated prices. At a price of 52 cents per Mcf for new gas, the FPC allows producers a 15 to 18 percent rate of return.

9. The FPC has increased producers' prices an average of 30 percent per year—considerably higher than the general rate of inflation. Yet reserve additions and commitments have continued to fall off (even accepting the industry's own reports).

10. Producers have not shown why the FPC's gas rates are inadequate. Nevertheless, the FPC consistently has been sympathetic to the producers' demands for higher prices.

11. Producers have spent billions of dollars on federal leases. Thus, it must be concluded that gas producers would not have spent this much money if they did not believe gas production would be profitable.

THE ADVERSE ECONOMIC IMPACT OF DEREGULATION

A December 1975, Library of Congress study indicates that without generating any additional supplies, deregulation of natural gas prices under the Krueger bill will cost between $12 and $14 billion a year. And, if a maximum of 3 trillion cubic feet of additional supplies are produced, the cost would range from $20 billion to $22 billion.

In addition, inflation would increase between eight tenths and nine tenths of a percentage point and unemployment would increase by a few hundred thousand.

Deregulation will not just hurt the residential user of natural gas. By far the largest user of natural gas, namely industry, will be forced to pass on price increases to consumers.

A REALISTIC VIEW OF POTENTIAL NATURAL GAS SUPPLIES[1]

The rate at which natural gas reserve additions can become available in the future is critically dependent on the size of the undiscovered but economically recoverable natural gas resource base. The prevailing opinion in the past has been that there is a vast amount of undiscovered natural gas remaining to be developed in the lower 48 States and the adjacent offshore waters. It has also been taken for granted that this large untapped resource could be developed readily by increasing the industry's exploration incentive. The belief in a vast undiscovered resource base has been based largely on estimates published over the years by both the United States Geological Survey (USGS) and by the Potential Gas Committee (PGC), an industry-sponsored group. In 1974, the USGS estimated that the lower 48 States' undiscovered natural gas resource base fell within a range of 725 to 1,450 trillion cubic feet (tcf.) with a 90 percent probability. Adding estimates for Alaska, the range increased to between 990 to 2000 tcf. The PGC estimate for undiscovered gas in the lower 48 States is 568 tcf.

The accuracy of these estimates is being called into question increasingly, however, not only by some of the major oil companies' geologists but by the National Academy of Sciences and the USGS itself. Just one year after issuing the above forecasts of potential reserves, the USGS revised its estimates radically downward, to 286 to 529 tcf. for the lower 48 States and 29 to 132 tcf. for Alaska, raising the total estimated U.S. reserve base to the 322 to 655 tcf. range.[2] These estimates are 60 to 70 percent smaller than the previous ones, despite the very large price increases that had taken place in the meantime. They reflect the pessimism with which the Nation's reserve base has come to be viewed in recent years. One must bear in mind, of course, that all such figures are extremely speculative.

ESTIMATES OF PRODUCTION POSSIBILITIES

With proven nationwide reserves now at 220 tcf., including Alaska's 26 tcf. of presently inaccessible gas, prospects for major increases in output during the remainder of this decade do not appear good. At present production rates, in fact, the upper limit of the total resource base estimates for the "lower 48" (including still undiscovered resources) will support only 26 more years of production, assuming that all of these reserves indeed can be found. Alaskan reserves could extend this horizon by up to 6½ years. The lower limit of the estimated resource base would sustain current production for only 15 years. In fact, these reserves will not be exhausted within such a short time, but if the resource-base estimates are valid, they augur substantial output declines in coming years.

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[1] From The Economics of the Natural Gas Controversy, a Staff Study for the use of the Subcommittee on Energy of the Joint Economic Committee, U.S. Congress. September 19, 1977, p. 28–48.

[2] U.S. Geological Survey, Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States, Circular 725. It should be noted that the total low and high values were not obtained by arithmetic summation but rather by statistical methods.

What production levels can realistically be expected from the lower 48 States? The recent FPC study,[3] provides some interesting insights. Figure 1 shows its estimates of production capabilities under various assumptions about reserve additions. Assumed reserve additions of 14.7 tcf. per year equal the 1960–1975 average for the 48 States, while 9.5 tcf. per year is the corresponding figure for 1968–75.

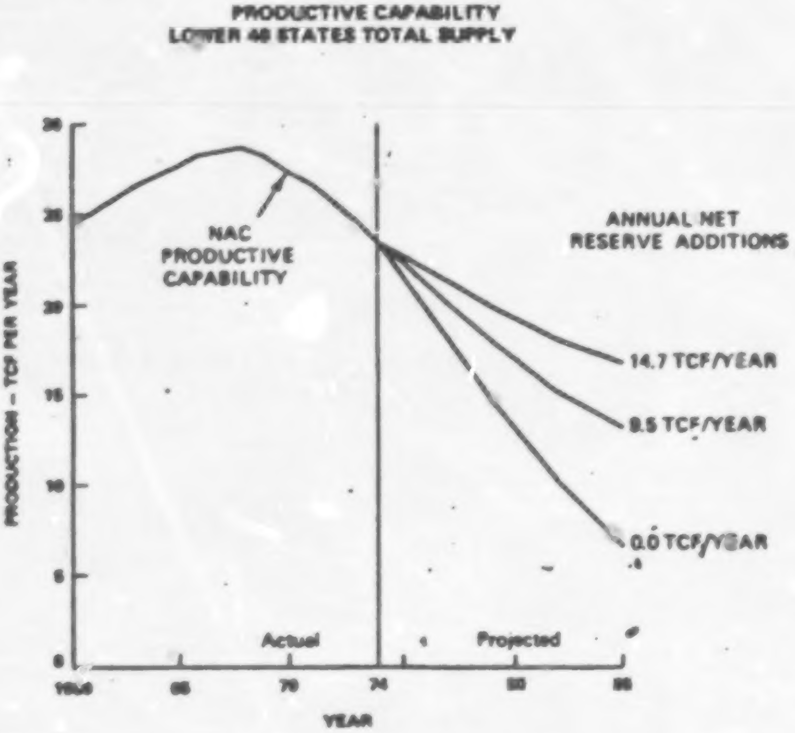

FIGURE 1

Source: F.P.C., A Realistic View of U.S. Natural Gas Supply.

Figure 2 shows the reserve additions needed to support various production growth rates. The 1960–1973 growth rate was 4.3 percent per year, one that would require implausibly large volumes of new reserves to be sustained in the future. Figures 1 and 2 show graphically the need for increased reserve additions if present production levels are to be maintained. They also demonstrate that sharp production declines can be expected in the near future if larger reserve additions are not attained.

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[3] A Realistic View of U.S. Natural Gas Supply, Federal Power Commission, Staff Report, December 1974.

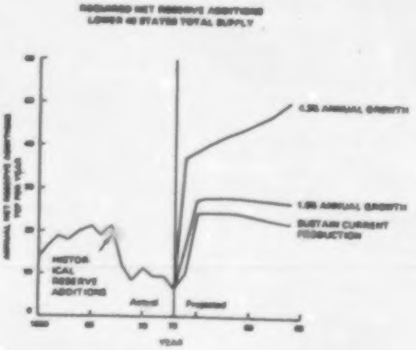

FIGURE 2

Source: F.P.C., A Realistic View of U.S. Natural Gas Supply.

Since 1970, numerous forecasts of future consumption and production levels have been made, some predicting output rates in excess of 50 tcf. per year within this century. Table 9 contains a summary of many of these forecasts in chronological order. Looking down the column for 1985, the trend over time toward diminishing expected production and consumption rates is clear.

The econometric supply projections appear to result in forecasts that are quite out of line with current thinking. Typical of these efforts is the MacAvoy-Pindyck[4] paper, published in 1975. Their findings are shown in Table 10, which is reproduced from that study. Viewed in 1977, these forecasts of 33 tcf. of gas production in 1980 at new gas prices of $1.00 per mcf. are not in accord with current perceptions of reality. This divergence implies that the parameters of production possibilities in the gas industry have changed fundamentally since the 1950 to 1970 period, probably due to the recent realization that the U.S. resource base already has been substantially exploited.

Unless recently revised perceptions are faulty, therefore, U.S. output of natural gas will continue to decline somewhat even at today's higher prices. This would be equally true at the price levels proposed by the Carter Administration and approved recently by the House of Representatives, or those resulting from lifting price controls. In fact, production is expected to decline—or at best to remain at present levels—at virtually any price level.

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[4] MacAvoy, Paul W., and Robert S. Pindyck, Price Controls and the Natural Gas Shortage, American Enterprise Institute, 1975.

TABLE 9.—FORECASTS OF U.S. NATURAL GAS CONSUMPTION

[In trillions of Btu's]

Source	1970	1975	1980	1985	1990	2000
SRI, 1970		23,848	29,871			
WEM, 1970			27,239		35,005	41,693
EBAS, 1970	21,900	26,000	30,400	35,000		
REF, 1971			27,329		35,005	47,097
BOM, 1971						[1] 35,914 [1] 57,482
NPC, 1971	23,338	22,420	22,480	22,180		
FRC, 1971	[2] 26,143	[2] 33,906	[2] 38,516	[2] 43,623	[2] 50,115	
RRFF, 1971		23,800	27,500			
PIRF, 1971		26,807	30,600	34,400		
CMB, 1972				27,161		
CMB, 1972						
DOI, 1972		25,220	26,980	28,390		33,980
FPC, 1973		25,009	24,331	25,680	28,870	33,908
FORD, 1974			[5] 28,000			[5] 32,000
AEC, 1974			[6] 29,600			[6] 30,500
CEQ, 1974						[5] 20,000
LLL, 1974			[4] 27,550	[4] 29,900		
FEA, 1974			[7] 23,140	24,775		
H. & J. 1975			26,800	28,022	28,612	[7] 28,639
ERDA, 1975			[8] 24,000			[8] 15,000
FPC, 1975			25,490	26,110	26,006	
CRS, 1975				19,000		
NEO, 1976				22,300		
LEVY, 1976				17,900		
NEO, 1977 (draft)				16,600		

[1] Excluded from graphs of natural gas forecasts given on following p. 5.

[2] The forecasts are estimated of energy requirements as defined by the Future Requirements Committee.

[3] Projection offered as scenario possibilities and not predictions; based on imports cut to half present levels, and imports at 3,000,000 barrels per day for 1985–2000.

[4] Assumes continuation of past relationship between energy consumption and GNP and further increase in the importance of electricity as a secondary energy source.

[5] Target projection associated with a program of energy conservation and environmental protection.

[6] Medium scenario projection.

[7] Base case projection assuming current policies will prevail without energy conservation; $11/bbl imported oil.

[8] No new initiatives scenario case.

KEY TO TABLE 9

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TABLE 10.—MACAVOY/PINDYCK ECONOMETRIC SIMULATIONS OF PHASED DEREGULATION OF NATURAL GAS

Year	New discoveries (Tcf)	Total additions to reserves (Tcf)	Total reserves (Tcf)	Supply of production (Tcf)	Demands for production (Tcf)	Excess demand for production (Tcf)	New contract price (cents per Mcf)	Average wholesale price (cents per Mcf)
1972	4.7	8.8	233.4	23.3	23.5	.2	31.7	39.9
1973	9.9	17.0	227.8	23.6	24.3	.7	34.7	41.4
1974	10.0	18.4	222.9	24.3	26.3	2.0	39.7	44.3
1975	16.3	24.8	222.3	26.4	28.7	2.3	64.7	52.7
1976	21.4	30.5	226.1	27.6	30.4	2.8	71.7	59.6
1977	25.4	35.3	233.9	28.6	31.9	3.3	78.8	66.3
1978	30.0	41.1	245.8	30.2	32.9	2.7	85.9	73.7
1979	31.5	43.9	258.6	32.1	33.7	1.6	93.1	81.1
1980	33.0	45.6	271.2	34.1	34.2	0.1	100.3	88.3

Source: Table 8, price controls and the natural gas shortage, American Enterprise Institute.

ENERGY PRICES AND PRODUCTION ECONOMICS

To understand the role of prices in determining future energy supply and the effects of sharp price changes on the industry, one must be familiar with the economics of mineral production. To judge by the current public debate, there is a need for education on these subjects. The following discussion will outline the economics of production, assuming initially that cost-price relationships are constant. Then it will consider the effect of a sharp increase in prices such as that which occurred in 1973. Finally, it will deal with the effect on production of an expectation of large future price increases.

PRODUCTION ECONOMICS WITH CONSTANT PRICES AND INPUT COSTS

Production of any mineral requires a sequence of decisions to proceed with successive exploration and development steps, each of which involves increased financial commitment. First, a geologically attractive property must be selected. Geophysical work must be done, and mineral rights must be leased. Typically, exploratory drilling will then commence. This investment is more or less risky depending on whether the property is in or adjacent to an area with known hydrocarbon deposits, or a truly wildcat effort distant from many other previous discoveries of oil or gas. Clearly the readiness to engage in exploratory drilling, particularly wildcatting, depends on the prospect that a find will be profitable to develop based on the price-cost relationships prevailing in the industry.

After an oil or gas deposit is located, the decision whether or not to proceed with development drilling and full-scale production depends primarily on the cost of the development drilling versus the volume of output expected over the lifetime of the well, taking cognizance of the distribution of output revenues over time. If the cost of development plus required profit margin is lower than or equal to the present value of revenues from the sale of output, then development of the deposit is attractive. The final decision to develop a find does not depend on the cost of initial exploration and wildcat drilling, because these costs are irretrievably "sunk" at the time of this decision.

Recovery rates from different wells can vary greatly. Thus, for instance, an offshore well that is expensive to drill does not necessarily mean high-cost oil or gas, because prolific offshore wells may produce at lower costs per barrel or mcf. than shallow onshore wells that are cheap to drill but have low output rates. Because of their high productivity, some expensive wells in the North Sea and in Alaska, for example, are expected to produce oil at wellhead costs of $2 per barrel or less.

At any given price, some finds will be attractive to produce while others are barely economic and some will be unprofitable to develop and will be left in the ground. At low prices the incentive to explore is low, and the profit requirement will mean that only relatively large deposits are produced. At prices in today's range, however, only wells with a very high ratio of cost to recoverable reserve (i.e., deposits with very high unit costs) will not be produced. At any price level, however, the prospective productivity of high-cost offshore wells must be substantially greater than that of onshore wells to justify development, and the expected recoverable reserves of a deep deposit must exceed those of one nearer to the surface to justify the disproportionately higher cost of deeper drilling. In the case of natural gas, moreover, the costs of delivering the gas to the nearest pipeline or gathering system also have a bearing on how much expense can be incurred to bring it to the surface.

The estimated profitability of potential output, taking account of drilling costs, well productivity, gathering, and other costs, determines the value of the mineral rights that the prospective producer must acquire before starting to drill. To the extent that these costs are accurately known, any profits in excess of normal returns to an entrepreneur's labor and capital will tend to be largely preempted by the landowner. Often, of course, the entrepreneur and the landowner are the same person (or organization).

THE EFFECTS OF SHARP PRICE CHANGES

Oil and gas drilling in the United States declined throughout the 1960s because the output prices of these fuels declined relative to the costs of drilling, squeezing the profit out of more and more prospective finds. The threat of imported oil at much lower prices was held at bay only by government restrictions on imports. Relatively few new drilling rigs were built; employment in domestic oil and gas fields declined; and the value of oil and gas drilling rights languished.

In early 1973, world oil prices rose to and exceeded U.S. levels. In October, the Arab oil embargo was declared, and, by December both Arab and non-Arab OPEC countries raised oil prices by some 250 percent. Prices for the output of new domestic oil wells and for natural gas in intrastate commerce were permitted to rise on the coattails of the cartel, while the controlled prices for already flowing oil and interstate gas were raised substantially during the following year. Certain additional categories of oil were released from controls and permitted to gravitate toward the world level.

This revolutionary increase in prices precipitated a boom in drilling by vastly increasing the profitability of finding oil or gas. Oil and gas production costs also rose rapidly, however, as producers bid eagerly for limited mineral rights and supplies of experienced labor and equipment, such as drilling rigs and pipe. Because windfall profits were neither suppressed nor effectively taxed away, the process of bidding for inputs tended to absorb them. Much of the excess profit remaining after payment of the variable costs of production were bid into the value of mineral rights. Pre-existing owners of mineral rights and other oilfield inputs enjoyed sudden, large gains. Among the major owners of mineral rights is the Federal Government with its jurisdiction over public lands and the Outer Continental Shelf.

This process of inflation did not stop with the oil (and gas) itself. Employees and suppliers of inputs not employed directly in drilling operations also commanded a share of the windfalls. It has been estimated that the variable costs of all domestic operations of ten major oil companies rose by 25 to 35 percent in one year from 1973 to 1974, not including the higher cost of crude oil purchased from others and the rise in oilfield investments.[5] In other words, the costs of equipment and supplies purchased from others and labor costs in all phases of the business rose by proportions in this range. Nor was the OPEC-induced inflation confined to the oil and gas industry. It spilled over to coal, uranium and electric power production, affecting all firms providing inputs to these industries as well. The rising costs for drilling in the United States stemming from cartelization of world oil prices outstripped yesteryear's regulated prices of interstate natural gas for most producing fields.

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[5] "Oil Profits, Prices, and Capital Requirements," Paper No. 1 of Volume 2 of a compendium, Achieving the Goals of the Employment Act of 1946—Thirtieth Anniversary Review, Joint Economic Committee, September, 1975.

Now four years after the energy price revolution, drilling activity continues to rise. Capacity to produce drill pipe, bits and rigs, as well as the supply of experienced oilfield personnel, is expanding, and the industry's cost structure has reached something approaching a new equilibrium. Moreover, certain elements in this cost structure—particularly the values of mineral rights—are flexible in the *downward* as well as upward direction. If the expected profitability of production should fall, due either to rises in other costs or to limitations on expected output prices (e.g., through imposition of a price ceiling on natural gas), it is not the incentive for future productive effort but rather the value of mineral rights which will absorb much of the decline. Such an adjustment in the values of mineral rights (basically a rent payment) will have minimal effect on incentive to develop and produce from most properties. Only in the case of properties that were *barely* profitable before the change in price-cost relationships occurred could a decision to produce from them be reversed. In these few cases, profitability would be suppressed, and such properties probably would be withdrawn from exploitation.

The large lease bonuses collected by the Federal Government indicate the high potential profitability of producing oil and gas at today's prices even in virgin territories in deep water. To the extent that the values of these mineral rights remains substantial, any limitation or even a rollback of oil or gas prices would have the effect mainly of limiting the increase in those values and not of limiting exploration and production on government lands.

Another important influence of the value of mineral rights, of course, is the Government's policy regarding the rate at which drilling rights on public lands are leased. An increase in the rate of leasing, other things equal, would tend to reduce the prices of all oil and gas rights. Simultaneously, however, it would tend to create scarcity and rising prices for other oilfield inputs. Such a policy would reduce long-term Treasury revenues from public lands and boost scarcity rents to private oilfield supplies. The inconsistency between the Government's interest in maximizing revenues from mineral leases and the Nation's interest in enhancing domestic energy output is a matter that must be resolved.

EFFECTS ON PRODUCTION OF EXPECTED PRICE INCREASES

If large increases in the future prices of oil or gas are anticipated, which continues to be the case, a producer with access to potential reserves must decide whether to produce for sale at current prices or to postpone production until prices rise. The decision will be based largely on the rate of return which may be earned by holding the reserves as an investment compared with that or alternatives in which the revenues from selling them can be invested. If the rate of energy price increase is higher than the return on alternative investments—e.g., the prevailing rate of interest—a producer will do better by holding his reserves. In this situation, energy in the ground is a better investment than money in the bank. This certainly has been the case in recent years with natural gas destined for the interstate market (which includes all gas on offshore Federal leases) and to some extent to other gas and oil.

Consider a producer who could have delivered natural gas for interstate commerce in 1970. A typical new gas price for that year was about 20 cents per mcf. If the producer delayed selling those reserves until 1976, when the national rate of $1.42 became effective, his gas had increased in value by 470 percent, or nearly 40 percent per year. Had the gas been sold in 1970, the producer would have been extremely unlikely to find an alternative investment with such a rate of return.

A strong incentive has existed to withhold gas for this reason. Anticipation of deregulation or rapid increases in national price ceilings continues to encourage such behavior. These expectations will hamper gas production so long as there is no clear-cut policy that gas price increases will be limited to moderate amounts. An unambiguous statement or legislative mandate establishing such a policy would greatly diminish the withholding incentive. Annual price adustments to offset inflation or for other reasons will not make withholding attractive so long as the appreciation of gas in the ground is no faster than the rate of return on alternative investments. Such a clarification of pricing policy must be a primary objective of Congress as it addresses natural gas regulatory legislation.

POLICY IMPLICATIONS OF THE SUPPLY SITUATION

Resource considerations should have a central role in shaping national gas policy. If the reserve base is indeed relatively small, and if only limited reserve additions can be anticipated, policies that limit consumption are in order. On the other hand, if perverse producer behavior under current and past FPC regulatory practice has led to reserve and production withholding, and if the past 10 years of reserve additions are substantially understated, perhaps current production levels can be maintained or even enlarged during the next 25 years.

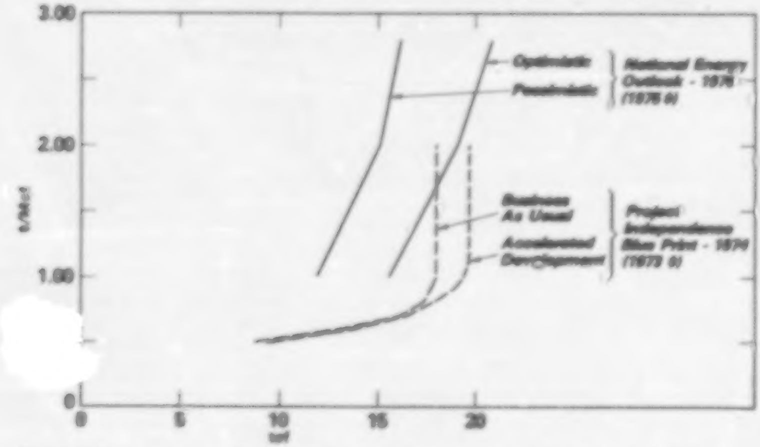
It is our judgment that increases in production above the present rate of less than 20 tcf. per year are unlikely, even under optimistic assumptions. The obvious implication of such a conclusion is that gas consumption should be discouraged generally, boiler fuel uses should be terminated, and the released supplies should be allocated to high-priority users. There are two basic approaches to limiting consumption and allocating supplies. These are (i) administrative measures controlling end uses and (ii) market-determined allocation using the price mechanism. Both of these will be discussed in later chapters. It would not appear advisable to rely exclusively on either. Instead, a combination is needed, as explained below.

In the face of rigid constraints on domestic supply and the very limited availability of natural gas imports, prices in the absence of controls could go to extremely high levels. High prices for domestic production can be justified, however, only to the extent that they serve U.S. national purposes such as reduced import dependency. The extent to which price levels beyond today's will increase production is questionable. The existing system of utility-type regulation for interstate gas, however, never was designed to cope with a situation of monopoly pricing in the energy market, such as that imposed by OPEC, and it must be replaced with a system that takes cognizance of the new circumstances.

Chart 1 illustrates why high, cartel-induced energy prices cannot be expected to bring forth substantial amounts of new gas supply. The chart is based on two Federal Energy Administration (FEA) analyses of supply. The first—from the 1974 *Project Independence Blueprint* (PIB)—shows clearly how inelastic 1985 supply is to prices above the $1.00 per mcf. (measured in 1973 dollars) level. A second analysis—contained in the 1976 *National Energy Outlook* (NEO)—shows a supply curve of similar shape. However, the NEO curve has moved upward due in part to inflation (NEO is measured in more inflated 1975 dollars), and in part to the fact that gas is simply becoming harder to find. The result is clear: the same amount of gas at higher prices.

Chart 1

Long Term Effect of Price on Natural Gas Production in 1985 - Non Associated Gas



NEO shows not only lower price sensitivity than PIB in the $1.00 to $2.00 range, but greater elasticity above $2.00. Nevertheless, there sems to be a well defined point with both PIB and NEO where the supply response is reduced. It would seem that the relevant point today would be somewhere in the $1.75 to $2.25 per mcf. range. However, even with NEO, elasticities are clearly less than 1. This means that every 1 percent price increase yields a 1985 supply increment substantially smaller than 1 percent.

The question is raised of how much should be paid—in terms of higher prices for all gas—for incremental supplies which are forthcoming in continuously diminishing volumes. If, for example, using the NEO optimistic scenario, 19 tcf. of associated gas can be produced at $2.00 per mcf. in 1985. At $2.50, 20 tcf. would be forthcoming. But the 19 tcf. would cost $38 billion, and the 20 tcf. produced under this scenario would have cost $50 billion. This means that the incremental 1 tcf. of output has a marginal cost of $12 billion, or a rather expensive $12.00 per mcf.

The great rise in oil prices in 1973 pulled the prices of uncontrolled intrastate natural gas up to similar levels. Controls on interstate natural gas prices will not be tenable without their extension to intrastate markets. If gas prices are not effectively controlled, moreover, they will tend to leapfrog the level of controlled oil prices and may rise to levels substantially above the equivalent of world oil prices set by the OPEC cartel. Such leapfrogging, if it occurred, would undermine the system of oil price controls by again driving up input costs and distorting the production incentives between oil and gas. It is strongly advisable, therefore, that natural gas prices be controlled at a level consistent with the regulated prices of oil, as proposed by the President and approved by the House of Representatives.

In the debate on energy prices and taxes, it should be recognized by all that for U.S. companies the profitability of new energy production in the United States remains higher and more secure than in virtually any other part of the world. Although the prices of new output are held slightly below world price levels, the taxes on production income are much lower than in other countries. In the OPEC nations, for instance, the producing companies now receive only a small service fee for lifting the oil. In the North Sea, the governments involved have taken controlling interests in the oil ventures. Thus, the incentives to find oil and gas in the United States remain among the strongest in the world, because it is only here that a person can produce and sell a barrel of oil or an mcf. of gas and keep most of the proceeds.

E. Future World Energy Supply

U.S. AND WORLD ENERGY OUTLOOK THROUGH 1990[*]

MAJOR FINDINGS

DEMAND

1. Assuming long-term real GNP growth in the United States of 3.5 percent per year for the period 1976–90, CRS base case projects 2.9 percent average annual energy growth rates. The energy demand forecast assumes no supply constraints but higher prices for oil and gas compared with the present.

2. Imposition of a gradually escalating Btu tax could result in bringing average annual energy growth rates down considerably, but the price to be paid for lower energy growth will be dependent on the ability of the economy to substitute labor, capital and other materials for energy. If there is enough flexibility in the economy, GNP growth rates and employment will only be marginally affected; if, on the other hand, there is little flexibility in the economy, the Btu tax could result in substantially lower GNP growth rates and higher unemployment. This is currently a matter of some controversy.

DOMESTIC SUPPLY

3. Under optimistic political and economic assumptions, domestic oil production could rise from 10.0 million barrels per day (b/d) in 1976 to 10.4 million b/d in 1980, 10.9 million b/d in 1985, and 11.4 million b/d by 1990. These supply figures assume—among other things—decontrol of oil and an aggressive OCS development plan. It seems more probable that the political and economic climate will be less favorable and finding rates lower than projected in the base case. This could result in production of 9.5 million b/d in 1980 and 1985 and 10.1 million b/d in 1990.

4. Under similar optimistic political and economic assumptions, natural gas production is projected to decline only gradually from 19.7 trillion cubic feet (TCF) in 1976 to 17.4 TCF in 1980, and 16.9 TCF each in 1985 and 1990. These supply figures assume early decontrol of new natural gas; an aggressive OCS development plan; a completed natural gas pipeline for Alaskan gas by 1985; very high-finding rates in frontier areas between 1976 and 1990. Under less optimistic, but currently more probable political and economic assumptions and continuing decline in gas findings in the lower 48 States, production is

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[*] From Project Independence: U.S. and World Energy Outlook Through 1990. A Report prepared by the Congressional Research Service and printed for the use of the House Committee on Interstate and Foreign Commerce, Senate Committee on Energy and Natural Resources, and Senate Committee on Commerce, Science and Transportation. November 1977, p. 3–6.

likely to decline faster to 16.3 TCF in 1980, 15.7 TCF in 1985, and 15.5 TCF in 1990.

5. Of all potential sources of synthetic fuels, only synthetic gas from coal is projected to make a substantial contribution to supply in 1985 (0.5 TCF) and 1990 (1.5 TCF). Potentially promising nonconventional sources of methane—such as methane occluded in coal, geopressure zones, and natural gas from Devonian shale and tight formation—are not expected to make a substantial contribution to U.S. energy supply between 1976 and 1990. Shale oil is projected to supply 75,000 b/d in 1985 and 200,000 b/d by 1990.

6. While coal reserves are huge, production is likely to be limited to 775 million tons in 1980, 940 million tons in 1985, and 1,225 million tons by 1900. Of these figures, about 80 million tons is projected for exports in 1980, and 90 million tons may be exported by 1985 and 1990. In terms of Btu's, production increases are lower due to the higher proportion of low-Btu western coal, as compared with current production from primarily higher Btu eastern coal. Coal production and utilization is subject to numerous constraints, and the domestic production and utilization figures used in the base case of this study assume that some impediments to higher coal use will be removed soon.

7. During the period of our forecast, the main constraint to expansion of nuclear power capacity is the rate of licensing new nuclear powerplants. The base case assumes that licensing will be speeded up from a recent low of about one plant every 8 weeks to about one plant every 5 weeks.

8. All other domestic energy sources: hydropower has been projected to increase slowly; geothermal is not likely to gain a role of significance during the next 15 years; and, solar energy is projected to supply about 1 percent of total U.S. energy demand in 1985 and 2 percent by 1990. The projected solar energy contribution assumes substantial government support for solar energy in the form of tax incentives.

CAPITAL

9. Uncertainties about energy policy have delayed investment decisions in many sectors of the energy industry. Capital requirements to meet projected energy supply are substantial, but can be met assuming prices will not be regulated to the extent of preventing a fair return on investment. Some form of government support in the form of price floors or loan guarantees might be needed to encourage development of high-risk energy sources such as shale oil, tar sands, synthetic gas, and other alternative energy resources.

OIL AND NATURAL GAS IMPORTS

10. Under base case demand and supply conditions laid down in this report, natural gas imports are expected to grow from 0.9 TCF in 1976 to 1.5 TCF in 1980, 2.1 TCF in 1985, and 2.4 TCF by 1990. Oil imports—crude oil and oil products—are projected to increase from 7.2 million b/d in 1976 to 10 million b/d in 1980, 11.8 million b/d in 1985.

11. Additional oil imports will come primarily from Arab countries in the Middle East and North Africa. Total U.S. imports from the Middle East and North Africa are projected to grow from about 2.5

million b/d in 1976 to 6.6 million b/d in 1980, 7.4 million b/d in 1985, and 7.9 million b/d by 1990. The adverse effects of another oil embargo on the economy at current and projected Arab oil import levels could be anywhere between very substantial and disastrous.

12. The implications of a dependence on the Middle East and North Africa in 1985 equal to total oil imports in 1976 are manifold and include: (*a*) potential oil supply interruptions as a result of war in the Middle East, or confrontation with the Soviet Union, or acts of sabotage by terrorist groups; (*b*) unknown effects of the accumulation of vast monetary reserves in Saudi Arabia and a few other Arab Gulf countries on the world economy; (*c*) potential conservation policies of Saudi Arabia or other Arab Gulf countries with limited capital absorptive capacity, resulting in escalating oil prices; (*d*) reduced leverage in the exercise of U.S. foreign policy in the region; (*e*) possible friction within the western alliance systems related to potential competition for available Middle East oil supplies.

13. World oil productive capacity can meet total world demand for oil throughout most of the decade of the 1980's, if the Soviet bloc does not become a major importer of oil. Sometime between the late 1980's and middle 1990's productive capacity of world oil is likely to peak, followed by declining world oil production (conventional oil sources only).

14. In spite of the production capacity there is no guarantee that producer states—in particular Saudi Arabia and a few smaller producers in the Arab Gulf region with low capital absorptive capacity—will continue to increase oil production. For political and economic reasons world oil demand could outpace supply as early as the early 1980's or as late as the early or middle 1990's. A few producer states—in particular Saudi Arabia—are likely to be in a position to determine when world oil production levels will peak. This action will be followed by subsequent world oil price increases.

15. Economic incentives by themselves are not likely to encourage the Saudis and other Arab Gulf producers with limited capital absorptive capacity to continue to increase oil production. A key incentive to a general atmosphere of cooperation between the industrial world and OAPEC is early progress toward a comprehensive peace settlement in the Arab-Israeli dispute. Other incentives to encourage further growth in OAPEC oil exports include: (*a*) progress in the "North-South" dialogs; (*b*) favorable foreign investment policy in the industrial world, encouraging surplus nations to produce more oil and invest their surpluses in the rest of the world; (*c*) assistance in modernization of developing oil-producing states, leading toward further interdependence between consumer and producer states.

16. There seems no practical way to avoid development and implementation of energy policies in the industrial world—spearheaded by the United States—leading to an aggressive conservation ethic and a major program of energy resource development. If the industrial nations can show that they are willing to make adequate sacrifices at home, leading to reduced long-term reliance on imported oil, the Gulf States may be convinced to fill the energy gap in the transition period. A considerable degree of cooperation and understanding of interdependence can only be avoided at great cost.

17. The Soviet bloc is not expected to become a major net exporter or importer of energy throughout the 1980's. The Peoples Republic of China is projected to export 0.5 million b/d in 1980 and 1 million b/d by 1985.

TABLE 1.—U.S. ENERGY DEMAND AND SUPPLY, 1977-90, PROJECTIONS

[In million barrels per day oil equivalent]

	1977	1980	1985	1990
Supply:				
Oil and NGL (in crude oil equivalent)	9.6	10.0	10.5	11.0
Natural gas	9.2	8.5	8.5	8.3
Shale oil			.08	.2
Nuclear power	1.5	2.3	3.4	5.0
Coal (supply for domestic)	6.7	6.8	7.7	10.5
Hydro/solar/geo	1.3	1.7	.9	2.4
Total, U.S. supply	28.3	29.3	32.3	37.4
Demand	36.9	40.4	45.1	51.5
Imports:				
Natural gas	.5	.7	1.0	1.2
Crude oil and products	8.1	10.0	11.8	12.9
Oil for oil storage program	.1	.4	.3	

CRUDE OIL

[In conventional units]

	1977	1980	1985	1990
Supply:				
NGL (million barrels per day)	8.1	8.9	9.5	9.9
Natural gas (trillion cubic feet per year)	18.6	17.4	16.9	16.9
Shale oil (million barrels pre day)			.08	.2
Nuclear power (gigawatts)	54	81	131	175
Coal (million shor tons per year utilization)	630	695	850	1.125
Hydro/solar/geo (gigawatts)	2.8	3.5	4.0	5.0
Imports:				
Natural gas (trillion cubic feet per year)	.99	1.5	2.1	2.4
Crude oil and products (million barrels per year)	8.1	10.0	11.8	12.9
Oil storage (million barrels per year)	.1	.4	.3	

THE COMING ENERGY SHORTAGE: OIL IS NOT ENOUGH

(By Paul S. Basile, Program Officer, W.A.E.S., M.I.T. and David Sternlight, Chief Economist, Atlantic Richfield Co.)*

Four years ago the "energy crisis" seemed to many no more than an episode in history—the result of a brief, unexpected, and exceptional action by a group of Arabian oil producers in the autumn of 1973. But we are now beginning to understand that the dislocations of 1973 were in fact first signs of very large, long-term problems. Studies by the Workshop on Alternative Energy Strategies (W.A.E.S.), established at M.I.T. two years ago, now make it clear that the world is moving steadily—and probably more rapidly than most of us have realized—towards a new and massive energy crisis, the result of rapid depletion of the fuels on which we have come to rely most heavily.

In particular, rapidly rising oil demand may outstrip supply in the non-Communist world as early as 1985, only eight years from now. Significant amounts of energy from alternative fuels may be needed in less than a decade to meet large and growing energy demand. Because large investments and long lead times are required to produce these fuels on a scale large enough to fill the prospective shortage of oil, the urgent task for the world is to begin now to manage a transition from dependence on oil to greater reliance on other fossil fuels, nuclear energy, and—ultimately—renewable energy systems.

PROBLEMS AND ALTERNATIVES

The Workshop on Alternative Energy Strategies, an experiment in international collaboration led by Professor Carroll L. Wilson of M.I.T., has been carried out over the past two-and-one-half years by senior academic, government, and industrial leaders in the principal western industrial nations and in Japan, Mexico, Iran, and Venezuela, each supported in each country by one or more active associates; and their studies have been coordinated and supplemented by a small central staff at M.I.T.

Participants and associates in each country developed estimates of the demands for energy and the preferred fuels for meeting those needs in their countries in 1985 and 2000, and they drew on their nations' best estimates of fuel reserves to determine domestic energy supplies likely to be available on those dates. Surpluses of fuels were assumed to be available for export. Estimates of energy supplies, demands, exports, and imports in other nations were added on the basis of data from those nations, from special W.A.E.S. studies, and from international sources.

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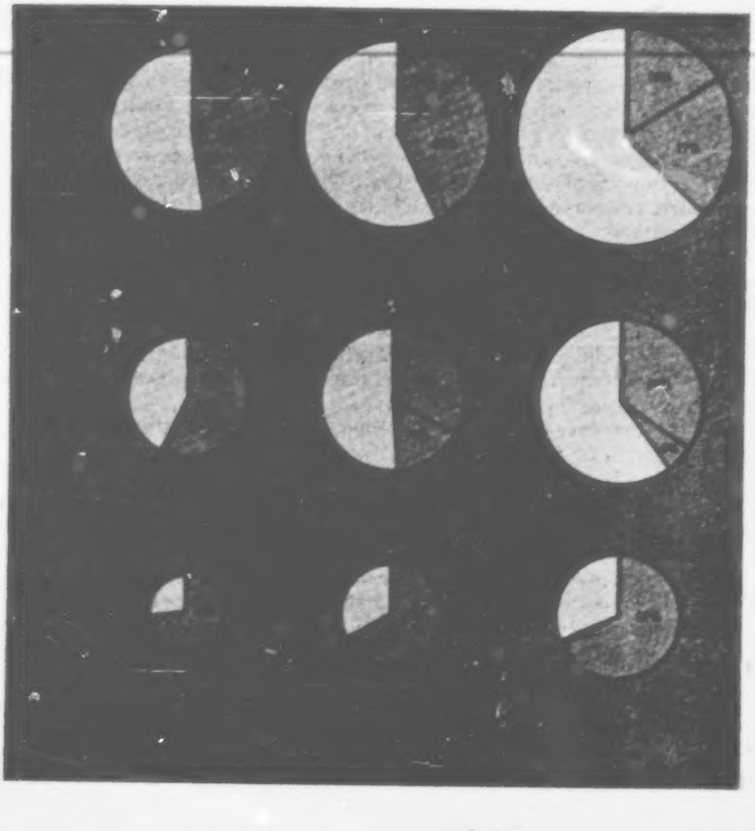
*This article is drawn from the concluding chapter of Energy: Global Prospects, 1985–2000, Carroll L. Wilson, Project Director, published on May 16 by McGraw Hill, New York; it presents the results of intensive studies by the Workshop on Alternative Energy Strategies (W.A.E.S.) including 70 participants and associates in 15 countries with a central staff at M.I.T., described in the article. Other reports resulting from the work of W.A.E.S. are listed as references at the end of the article. Professor Wilson, who retired last year from the Sloan School of Management, has held the Mitsui Chair in Problems in Contemporary Technology. © 1977 by the Alumni Association of the Massachusetts Institute of Technology. Reprinted by permission.

Prevailing national and international economic conditions affect the demand for energy, and energy prices and national energy policies affect both supply and demand. Members of W.A.E.S. therefore agreed that their supply and demand estimates would be made on the basis of agreed alternative scenarios for energy prices, politics, and economic growth. Five such scenarios, shown in the table on page 470, were studied to 1985. One of them—postulating falling real energy prices and high world economic growth—was soon demonstrated to lead to energy demand inconsistent with all conceivable supplies by 1985; two other cases, with rising energy prices, resulted in supplies somewhat in excess of demand by 1985; the economic implications of the rising prices could be severe. The remaining two cases, one based on low growth and the other on higher economic growth, and both with constant fuel prices, produced supplies adequate to meet demand through 1985 and were thus also used as the basis of analysis to the year 2000.



There is no escaping the central issue of oil in the coming "energy crisis." This chart shows the oil consumption of North America, Western Europe, and Japan as a proportion of total energy use in 1972 and these regions' expected oil consumption in 1985 and 2000 under conditions of high economic growth and high fuel prices (Case C on page 470). The numbers in parentheses show the total energy demand, in millions of barrels per day oil equivalent, in each case; the areas of the circles are in proportion to these totals. North America is the only region that is also a significant producer; but its projected imports are large, and they represent a substantial drain on world oil supplies in 1985 and 2000. In total, the prodigious desired imports of energy in the form of oil shown on this chart will exceed available supplies by soon after 1985, according to W.A.E.S. analyses, necessitating fuel substitutions and major conservation efforts.

Using these five—and, after 1985, two—scenarios, W.A.E.S. analysts in 13 countries made estimates of their countries' energy demands, preferred fuels for meeting those demands, and resources from which those fuels would come. These supply and demand estimates were then summed to reveal the prospective gaps (or surpluses) between national expectations for imports and probable available exports to yield the results cited in the previous paragraph. But shortfalls or surpluses cannot exist in the real world. A scenario that fails to balance is a signal that some expectations will not be fulfilled and that the market will clear through some combination of price, economic growth, and energy policy not within the scenario.

The interactions of energy demand and supply in the real world are complex. They involve consumer preferences for certain fuels based on the price, convenience, cleanliness, and reliability of supply of those fuels. They involve producers' decisions based on perceived demands, prices, and costs—and on their willingness to make needed investments. They involve the extent of existing energy processing, refining, transport, conversion, and distribution systems and the potential for their expansion. And they involve a myriad of national political decisions that may motivate and facilitate—or discourage and impede—a diversification of supply sources, or an emphasis on certain fuels in preference to other fuels.

In W.A.E.S. we have tried to incorporate all these variables in the conceptual models we have used for our analyses of global energy prospects to the year 2000. As a result, our integration process can reveal both problems and policy alternatives:

It can reveal specific problems in a particular country or region—such as shifts in the mix of fuels needed to reach supply-demand balances.

It can suggest the cost, infrastructure, and timing of efforts required to balance supply and demand. What does a U.S.A.-Europe coal trade involve?

It can reveal the most economically efficient (least total cost to world consumers) adjustments, within tight physical and political constraints, for closing supply-demand gaps.

It permits policy analysis: policies, costs, technical potentials, demand targets, and timings can all be varied.

We used two integration procedures. We first assembled data on "preferred" fuels for fulfilling energy requirements without considering the availability of desired energy imports; this is our global *unconstrained integration.* Then we performed global *constrained integrations*, in which we forced the fuel mix (for the same energy demand) to conform to fuels availability. The first form of integration reveals supply-demand imbalances, while the second shows how the balancing of supply and demand may be achieved.

In the unconstrained integrations, preferred national demands for energy and for each fuel are used to examine how energy moves from raw source to end use and the energy losses at each stage along the way. We also summarize the indigenous supplies for meeting those demands. Supplies and demands rarely balance, and the net difference is the implied requirement for imports or implied availability of exports of each fuel by each country in each scenario case.

These national projections are added together in the global integration process to reveal whether demand and supply are globally in balance. If the answer is yes, fuels can be allocated in world trade so that potential exports balance unfilled demands. If demand and supply do not balance, then the gaps represent differences between national expectations and the realities of globally limited fuel supplies—the scale and timing of global energy and fuel gaps.

In constrained integrations we force shifts in the fuel mix beyond the range of consumer preferences to meet stated energy requirements. These shifts are based on global supplies. Constrainted integrations are done to see if it is possible to close prospective supply-demand gaps in a particular scenario—and to determine changes required in the energy system to do so. Such analyses were supported by GEMM, the Global Energy Mini-Model (a highly constrained linear programming model) developed at Atlantic Richfield Co. for the W.A.E.S. project.

The basic rule for making decisions in these calculations is: meet all end-use energy demand as nearly as possible—that is, make total energy supply and demand balance through that expansion of supply, processing, distribution, and use infrastructure (within any technical or political limits) which results in least total cost to world consumers. To achieve such a balance in stressed scenarios where some (preferred) fuels are in shortage while others (not preferred) are in surplus, substantial fuel switching was found necessary. This was done so that each fuel was used with maximum efficiency, minimizing losses in processing and conversion.

OIL EMERGES AS THE CRITICAL RESOURCE

The outstanding result from our analysis of energy supply and demand over the period to the year 2000 is the inevitability of growing future shortages of oil over reasonable ranges of energy prices, policies, and economic growth. Oil demand is projected by our data to increase by about 10 million barrels a day every six years after 1975, reaching 63 million barrels a day by 1985. But oil production in the non-Communist world is unlikely to exceed 70 million barrels a day at any time, and resource and production limitations will begin to restrict oil supply sometime between 1985 and 1990. Further increases in oil demand beyond 1990 simply cannot be satisfied, and those energy requirements must be met with other fuels.

Filling the prospective oil shortfall becomes increasingly difficult as we approach the end of the century. What begins as a minor discrepancy before 1990 widens rapidly in typical cases to a gaping deficit of some 20 million barrels a day by the year 2000. This is equivalent to an oil flow greater than half of O.P.E.C.'s maximum production to date (30.5 million barrels per day in 1973); it is approximately equivalent to the total energy consumption of western Europe and Japan today.

This picture persists under a variety of assumptions; the problem does not go away within the range of any of the W.A.E.S. scenarios about economic growth, energy price, and national policy between now and the year 2000. In each of our cases this oil shortfall is nearly 30 per cent of total potential oil production of all the non-Communist nations in the year 2000.

Under all W.A.E.S. scenarios studied, oil production in the non-Communist world fails to meet demand sometime between 1985 and 2000. The demand line on this chart is based on Case C assumptions (see table, page 470)—high economic growth rate, rising energy price, vigorous government response, and gross additions to oil reserves of 20 billion barrels per year. The high curve ("No O.P.E.C. production limit") assumes that exporters produce oil as rapidly as technical and physical constraints permit. The lower curves assume that O.P.E.C. production is limited due to political or economic considerations; the lowest illustrates the effect on world oil supply of O.P.E.C. maintaining present ceilings of 33 million barrels/day.

Our projections of energy supplies and demands—and imports and/or exports—for the major consuming and producing regions are summarized in the charts on page 467. These illustrate the relative import-dependence of the consuming regions and the potential exports from producing regions between 1972 and 2000 under conditions of rapid economic growth, vigorous government energy policies—including strong conservation measures—and rising energy prices. They show that total energy demand will exceed supply in the year 2000 by only between 5 and 8 percent. But they reveal a much more important problem: the very large imbalance between the supply of and demand for oil. No small adjustments will suffice to correct this real imbalance.

GAS AND COAL IMPORTS AND EXPORTS

The situation with respect to natural gas is not as critical. The W.A.E.S. analysis shows that the reserves of gas in the O.P.E.C.

nations are sufficient to meet major importers' desired imports, as well as to provide for increasing domestic requirements. However, 12 to 17 percent of total gas demand will have to be met by importing; this is far in excess of present gas trade, and ways must be found to move the increased amounts of gas to markets. Alternatively, demands must be reduced through conservation or acceptance of substitute fuels.

Coal is not, we find, a "preferred" fuel, because of problems due to pollution and handling. Yet the maximum potential for coal production exceeds desired coal demands by as much as 30 percent of total coal demand. Nearly all coal demand estimates are based on estimates of indigenous production from known supplies in each country. Potential global exports are greatly in excess of desired imports. In fact, prospective coal surpluses are about the same size as total desired coal imports under conditions where other fuels are available.

If demands for coal could be increased (as a substitute for oil and gas), these coal surpluses could be used to help close the oil gap. Strategies for the use, transport, and conversion of coal are obviously of critical importance.

FUEL SWITCHING FOR ENERGY BALANCING

Energy imbalances revealed in our analyses of prospective supply and demand cannot occur in the real world; some demands will have to be reduced or supplies increased. Prices above those we assumed, rationing, still lower economic growth than in our assumptions, etc., all would reduce demand; yet such dislocations and disruptions can be very undesirable "solutions." They may in fact be energy disasters.

The purpose of the W.A.E.S. constrained integrations is to analyze alternatives for resolving these potential imbalances. When desired fuel mixes lead to demand in excess of supply, one useful adjustment is to allocate fuels to uses in such a way that the energy content of each fuel is put to maximum use. For example, the substantial heat loss associated wtih converting fossil fuel into electricity can be reduced by putting fossil fuels in end-use markets as fuels—not in electric power plants—while using other options such as nuclear for generating electricity.

Our constrained integrations, which incorporate such steps, do not represent "predictions" of future energy sources and uses. Rather, they represent a description of a situation in which all fuels are used in their most efficient way, within reasonable physical constraints, given the particular W.A.E.S. economic, policy, and price assumptions. They show what might be done with concerted fuel-switching actions, and we believe they show the two major directions in which we must move if we are to match supplies and demands to obtain an energy balance to the end of the century:

—All energy resources and conservation measures must be pursued vigorously to meet total projected demand. Low levels of coal or nuclear development, or less-than-aggressive conservation, would result in the failure of energy supplies to meet projected demand levels at reasonable prices and rates of economic growth.

—Energy supplies in the 1990s will depend on decisions taken in the next few years—a period when we are unlikely to have severe energy imbalances. It is critically important to look beyond the next decade in making today's policy decisions.

ENERGY BALANCES AND IMBALANCES IN 1985

Within the range of W.A.E.S. assumptions, peaking of world oil production will take place somewhere between 1981 and 2004; this is the critical energy problem for the world—the peak and decline of oil production in the face of rising oil demands. The year 1985 thus becomes of special interest for study.

For 1985, W.A.E.S. energy supply-demand integrations reveal:

> With a constant oil price ($11.50 per barrel in 1975 U.S. dollars) and real economic growth ranging from 3.4 to 5.2 per cent per year worldwide, sufficient supplies of energy are potentially available to meet total demands. In addition, demands for each fuel can be met with projected supplies.
>
> With an oil price rising to $17.25 per barrel (1975 U.S. dollars) by 1985 and economic growth between 3.4 and 5.2 per cent per year, there appear to be significant potential surpluses of all fuels over consumers' preferences for those fuels. The implication is that the price of $17.25 is probably higher than needed to bring on sufficient supplies and—therefore—that energy prices are not likely to reach that figure by 1985.
>
> With a falling oil price (to $7.66 per barrel in 1975 U.S. dollars) and high economic growth (5.2 per cent per year worldwide), there are insufficient quantities of certain fuels available to meet consumers' preferences for those fuels in 1985. In addition, total available energy falls short of total demand. The case indicates that an oil price of $7.66, coupled with high economic growth, will not generate sufficient supplies to support the high demands resulting at that price.

While all cases but the falling-price scenario "balance" in 1985, it should be remembered that the estimates assume maximum potential supplies consistent with our assumptions. Given lead times of five to ten years or more for many projects, failure within the next year to make commitments, to resolve the many current constraints on production, and to develop future supplies may foreclose some options for 1985.

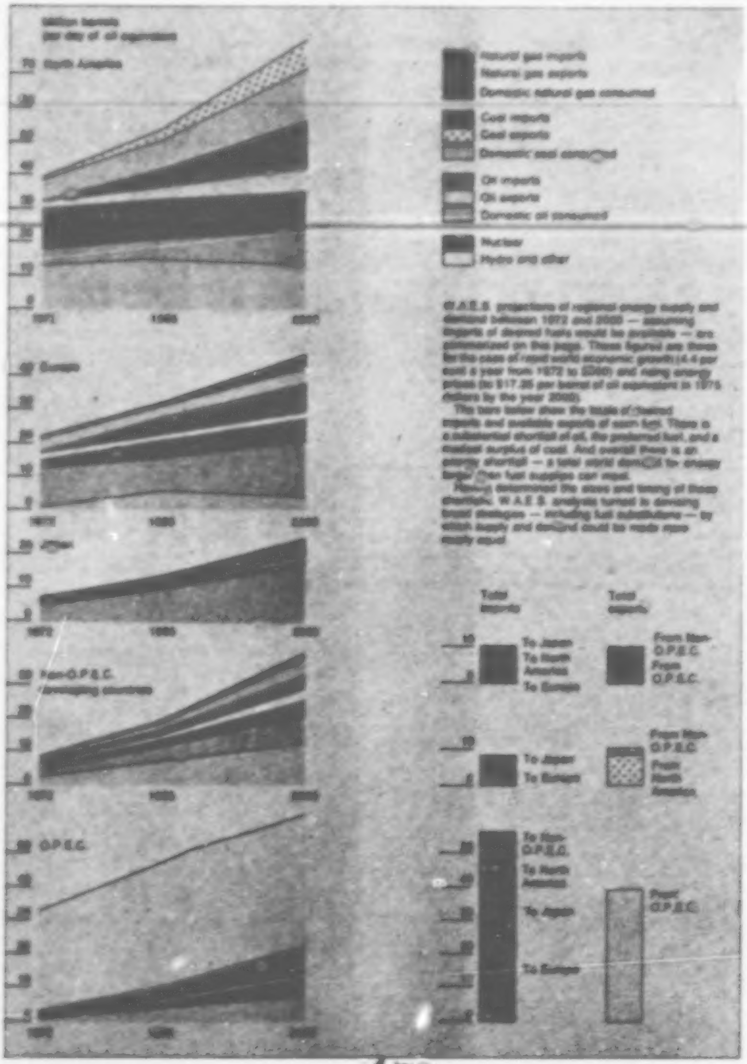
ENERGY BALANCES AND IMBALANCES IN 2000

In nearly all of our cases for the year 2000, the total of energy demands exceeds expected supplies. Even with the most efficient mix of fuels this is so; with "preferred" mixes, the discrepancy is larger.

Even more important than the overall discrepancy are the prospective shortages of specific fuels. The most important of these are significant oil gaps—prospective shortfalls between potential (maximum) oil supply and preferred oil demand based on our assumptions. For example, with rising energy price (to $17.25 by 2000) and high economic growth (4.0 per cent per year) from 1985 to 2000, potential oil available in the world in the year 2000 falls short of the desired oil demand by some 20 million barrels a day. With constant energy price ($11.50) and low economic growth (2.8 per cent per year) to 2000, the oil shortfall is some 15 million barrels per day. These prospective shortages represent, in each case, about 30 per cent of the total desired oil imports of the non-Communist nations. In other words, given the assumptions of these W.A.E.S. cases, only about two-thirds of the aggregate desired global oil imports could be met by available oil exports from producers in the year 2000.

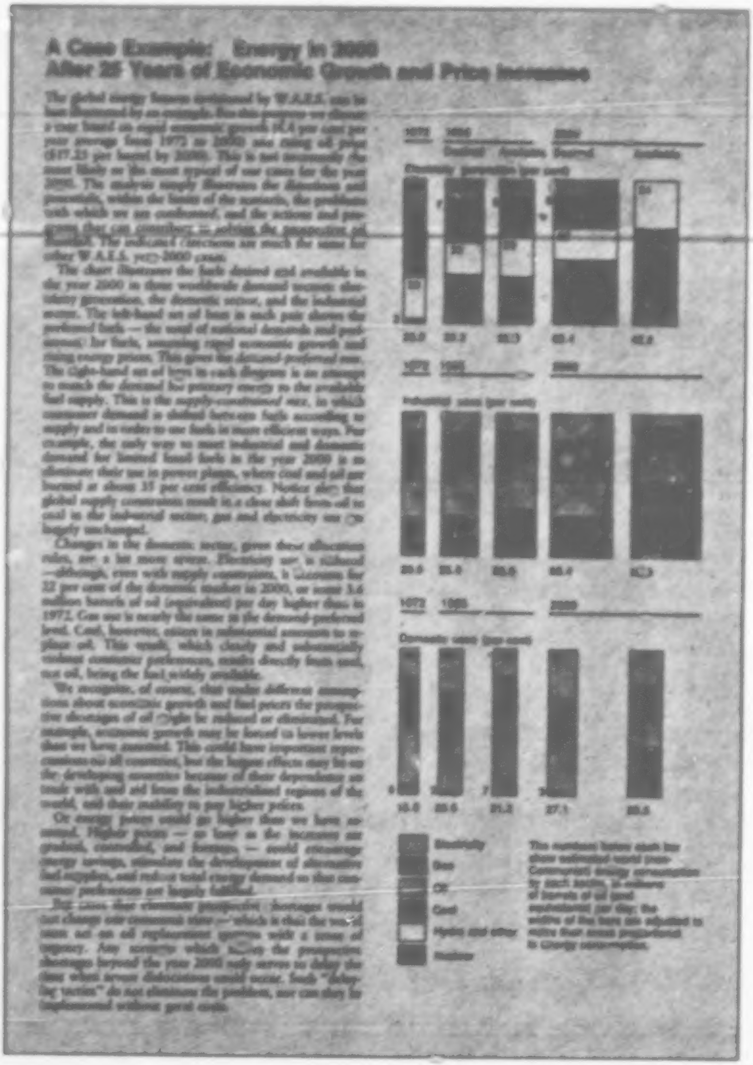
On the basis of these and other cases studied, we therefore conclude that world oil demand will probably overtake supplies sometime between 1981 and 2004 under any set of plausible assumptions.

Natural gas supply and demand balance closely in the year 2000, but global totals obscure the real point about natural gas. The gas supply-demand mismatch in the year 2000 is localized; the supply is not in the same geographical regions as the demand. For all our cases, some 3 to 4 million barrels per day (oil equivalent) of expanded trade—trade in excess of present operational and planned projects—would be needed in 2000 to meet desired gas demands. If gas demands are unmet it will be because of infrastructure limitations—inadequate pipeline and LNG tanker capacity—rather than resource limitations.



The coal outlook is quite different. Coal is not a preferred fuel. It produces substantial pollutants when burned (which can be avoided only at considerable expense), creates ashes to be disposed of, and is not easily handled for transport; furthermore, many changes in existing user devices would be required for its widespread adoption. Yet world reserves of coal are enormous and largely untapped.

In every case studied by W.A.E.S., maximum potential world coal production exceeds desired coal demand by some 1.9 to 8.2 million barrels of oil equivalent per day (140 to 620 tons of coal per year) in 2000. These prospective coal surpluses are between 10 to 50 per cent of the prospective oil gap in each case. Coal thus is a potentially important replacement fuel for oil, on a global scale.



A Case Example: Energy in 2000
After 25 Years of Economic Growth and Price Increases

In summary, our supply-demand integrations to the year 2000 indicate that energy and fuel shortfalls are probable, and that they could be partially filled through such major fuel substitutions as these:

Nearly all fossil fuels to be removed from use in electric power plants, to reduce processing losses;

Significantly more coal (and solar and other alternative fuels) and less oil and electricity to be used in industrial and domestic sectors; and

Synthetic crude oil to be made from available coal supplies, in order to meet essential demands (such as those for transport and petrochemical feedstocks) for liquid fuel.

UNCERTAINTIES AND OTHER HYPOTHESES

The ability to foresee that some things cannot be foreseen is essential. There are no seers who can look 10 or 25 years into the future with assured accuracy. Any study such as ours must recognize a number of categories and characteristics of uncertainties—some of which could overturn the trends in our projections. To avoid neglecting some uncertain or unknown, but possible, events of the next 25 years, we can ask: what if some events presently anticipated were not to occur? Or what if some unexpected events should take place? In either case, what might be the consequences?

The W.A.E.S. methodology and analysis are based on a set of futures without large discontinuities—either major new technologies or large interruptions or disasters. Such factors cannot be included in a systematic, quantitative way in the analysis—and it is probably inappropriate to try. Although large unanticipated events do occur in the real world, "luck" cannot be the basis for responsible national policy planning.

Some events could ease the transitions which lie ahead. Others could create very large problems.

Technological breakthroughs in a number of areas could have substantial impacts. Processes for large-scale *in situ* production of oil from shale, oil sands, and/or heavy oil; an increase in oil recovery significantly above 40 per cent; *in situ* coal gasification; commercially available fusion power; and rapid development and distribution of low-cost solar technologies—all could "make" or "break" any given set of projections. We consider it wiser to classify unanticipated bonuses of this kind as just that: bonuses. To do otherwise would be most imprudent.

On the other hand, the possibility of discontinuities and disasters cannot be ignored in good planning, either. The next 25 years could see, for example: runaway inflation or prolonged depression; local or regional wars or coups d'etat affecting energy supplies; major energy-related accidents; or terrorist activities. If any such unanticipated events were to occur, our future might be considerably different.

A hint of how some alternatives might affect the future is given in our analysis of a future with low real economic growth (2.8 per cent per year from 1985 to 2000) and rising energy prices (to $17.25 per barrel by 2000). This is a "low-demand/high-supply" case—at least relative to the other W.A.E.S. cases studied.

Under these assumptions, we find that oil and gas are probably sufficient to meet preferred demands for these fuels in the year 2000.

This result assumes, of course, the W.A.E.S. "high" (45 million barrels per day) estimated of O.P.E.C. production: oil is still, in this case, the most important global fuel. The small margins of deficit or surplus in this case are probably well within the limits of uncertainty of the numbers themselves. Yet even if this case does balance—even if potential supplies are in fact sufficient to meet desired demands in 2000—this case just stretches the time-scale. The same mismatch between supply and demand as in other cases appears by 2005 or 2010 in the analyses. This postponement might allow more time for the eventual transition, more time to develop new technologies and renewable energy forms. But these technologies must be developed and this time must be used.

THE CRITICAL YEARS ARE NOW

The years through 1985 are critical ones. Events and policy decisions in the decade before 1985 will determine success in demand reduction, fuel substitution, or additions to supply in the 1985–2000 period. We are, in 1977, on the threshold of a critical decision period. We cannot afford to waste the years immediately ahead if we are to have any large-scale energy options available before the end of the century. The time for decisive action is now.

Actions are required on a large scale to avoid shortages. The size of the gap is large and its inception is soon. Balancing energy supply and demand by 2000 in an acceptable manner will require great effort. The alternative could be severe economic and political dislocations resulting from sharp energy price increases and perhaps other, more difficult events.

The period from now to the end of the century must be one of energy transition—away from oil as the world's dominant fuel. For this to be a smooth transition, greater international cooperation among increasingly interdependent nations is essential. Vigorous research, development, and demonstration of new supply sources, conservation, and fuel-switching programs must move forward quickly on an international scale. The timing of future energy-related programs and plans must take account of the challenges of this critical period. Our energy world then and in the 21st century depends on it.

	Case A	Case B	Case C	Case D	Case E
1977-85:					
Economic growth rate	High: 5.2 percent per year.	Low: 3.4 percent per year.	High: 5.2 percent per year.	Low: 3.4 percent per year.	High: 5.2 percent per year.
Energy price (see caption)	Rising: $17. 25.	Rising: $17. 25.	Constant: $11. 50.	Constant: $11. 50.	Falling: $7. 66.
National energy policy response	Vigorous	Vigorous	Vigorous	Restrained	Restrained.
1985-2000:					
Economic growth rate			High: 4. percent per year.	Low: 2.8 percent per year.	
Energy price			Rising: $17, 25.	Constant: $11, 50.	
Additions to oil reserves			High: 20, 000, 000, 000 bbl per year.	Low: 10, 000, 000, 000 bbl per year.	
Maximum O.P.E.C. oil production			High: 45, 000 bbl per day.	Low: 40, 000, 000 bbl per day.	
National energy policy response			Vigorous	Vigorous	
Principal replacement fuel			Coal or nuclear.	Coal or nuclear.	

W.A.E.S. analyses of future energy supply and demand are based on the key global variables combined into the scenarios (cases) shown in this table. Analyses of the situation to 1985 made it clear that Case E was inconsistent—demand far outran supply before 1985—and that the high prices postulated in Cases A and B would result in substantial energy surpluses—and presumably severe economic dislocations—in 1985. Studies of Cases C and D, in which demand and supply were closely matched in 1985, were continued to 2000. All energy prices are per barrel of Arabian light crude oil, f.o.b. Persian Gulf, or equivalent, in 1975 dollars.

References: In addition to the principal report of the Workshop on Alternative Energy Strategies from which this article has been developed (*Energy: Global Prospects 1985–2000*; New York: McGraw Hill, 1977, $14.95 in cloth, $6.95 paperback), three technical volumes contain much of the detailed analysis upon which the W.A.E.S. findings are based. These are *Energy Demand Studies: Major Consuming Countries* (1976), *Energy Supply to the Year 2000: Global and National Studies* (1977), and *Energy Supply-Demand Integration to the Year 2000: Global and National Studies* (1977). All three have been published in the years indicated by the M.I.T. Press, Cambridge, Mass.

F. Energy and Social Change

THE CENTRIFUGAL SOCIAL EFFECTS OF ENERGY

(By Rufus Miles)[*]

Is there any dominant cause of the disruptions in technological society that might be within our power to control, assuming we have the wisdom to take the necessary action? Astonishing as it may seem, the excessive consumption of energy may be just such a cause. Energy is the central dynamic of our society, the taproot of affluence, but it powers a social centrifuge, spinning people apart. Its effects deserve the closest analysis.

Ever since Prometheus stole from Athena and Hephaestus the gifts of fire and tools, man has regarded energy as an unmitigated blessing. Until the modern age, most of the energy he employed to augment the power of his muscles came from strong and docile animals, from the burning of wood, and from interruption of the flow of wind and water. In such modest quantities as these sources yielded, energy could hardly be considered anything but a boon. Only when men learned to convert the stored energy of fossil fuels on a massive scale did the combinaton of energy and technology begin to remake the physical face of the earth in dangerously adverse ways and generate an incomprehensibly complex society. Only in the smidgeon of history represented by the lifetime of today's senior citizens have there been societies that were overwhelmingly urban and suburban, where the typical citizen guides himself several thousand miles each year over streets and highways in a machine that consumes millions of joules of energy and others are transported tens of thousands more miles through the air. Only in this recent, thin slice of time has most work been performed not by humans or domesticated animals, but by machines using fossil fuels or electricity generated from fossil fuels.

That energy from such fuels was the foremost factor in converting American society from being nearly three-quarters rural in 1880 to nearly three-quarters urban in 1970 can hardly be doubted. Advanced technology had existed for centuries—how else could St. Peter's basilica have been built?—without producing any large, predominantly urban societies. It was the coupling of fossil fuels with the steam engine, the internal-combustion engine, the turbine, the turbo-generator, and the electric motor that produced America's technological society. Without these, modernization would have been impossible; with them, it appears to have been inevitable—as long as fossil fuels, and particularly petroleum, existed in plentiful supply. These were the engines of urbanization, high-rise buildings, suburbanization, freeways and shopping centers; ultimately, they could be considered the unindicted subverters of the traditional foundations of society. Modernization would have been possible without the automobile, but not American-style modernization.

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[*] From Awakening from the American Dream: The Social and Political Limits to Growth © Rufus E. Miles, Jr., published by Universe Books, New York 1976 and reprinted with permission, p. 89–103. Rufus Miles is a senior fellow and lecturer at the Woodrow Wilson School of Public and International Affairs, Princeton University.

Just what is it that this symbiosis of fossil fuels and technology has done to society? To begin with, it has created an intense energy addiction. Without huge amounts of energy, every modern city would come to a mechanical stop and turn to chaos; every mechanized farm would be unable to plant or harvest its crops; every industry would come to a grinding halt; every apartment building and virtually every home would be paralyzed. In the short run, there is no conceivable way a highly modernized society can kick this energy addiction, and not much evidence that it wants to, although the numbers of individuals who would like to do so are growing daily. More important still, the high consumption of energy has had a profound impact on the two most fundamental institutions of all previous societies: the family and the community.

THE IMPACT OF ENERGY AND MODERNIZATION ON THE FAMILY

That the family has been the basic building block of all prior societies seems well established. In any essay summarizing the most general propositions about which sociologists should be able to agree, Princeton sociologist Marion Levy has this, among other things, to say about the fundamental role of the family: "There are no known societies lacking in family structures. . . . Until relatively modernized societies developed, the vast majority of all people in history spent the majority of their time and had the majority of their interrelationships in a family context. Ideally and/or actually—even if not ideally—the family context was the major focus of organizational behavior. It still is for a large proportion of the people of this earth." The words, "until relatively modernized societies developed" imply, of course, that modernization was responsible for demoting the family from its position of centrality. If we accept, for the purposes of this analysis, the contention that modernization's foremost characteristic is the consumption of large amounts of energy coupled with advancing technology, then energy can be said to be the driving force behind the demotion of the family as a social institution.

The centrifugal effect of energy upon the family accords with common observation. The strains created by urbanization and the wage economy, the sharp diminution in the amount of time spent by fathers and mothers with sons and daughters in joint economic and survival efforts, as compared with agrarian societies, and by grandparents with younger generations, has obviously loosened family ties. When children became economic liabilities and hindrances to alternative forms of self-fulfillment, the gradual decline in the importance of the family became inevitable. Children became luxuries, often more expensive than Cadillacs.

To the extent that energy is responsible for the extreme urbanization and modernization of society, therefore, it seems fair to say that it is responsible for the decline of the importance of the family as the central building block of society. And to the extent that families are valued, either for their own sake or as an institution believed to be essential to the stability and durability of society, the use of large quantities of energy—large enough to produce extreme urbanization and modernization—can be said to have a negative effect.

Just how essential a healthy family structure may be to the preservation of a reasonably durable society, we can only speculate since no society has ever tried before the 20th century to operate without building upon the family as its most fundamental institution. This fact alone would seem to create a fairly strong inference that creating conditions unfavorable to the family without developing an assured and tested substitute might be a hazardous course. So far, the capacity of highly modernized societies to create effective substitutes or collateral institutions which can, in conjunction with weakened families, provide an equally firm foundation is not evident.

The educational system has been unsuccessful in serving, for our current society, in the role formerly performed successfully by the family in a low-energy society—that is, to prepare young people for adult life. If it cannot succeed in this vital role under current conditions, one must wonder what other social institution or system can. The damage done to the family by high-energy technology may be irreparable within the context of a society that is as overwhelmingly urbanized, as specialized and compartmentalized, as highly centralized and bureaucratized as is America. It may be necessary to face the almost inescapable conclusion that only a basic change of direction might reverse the deterioration of the family as an institution.

The family deserves consideration as much or more for its past and potential contributions to basic human psychological satisfactions as for its function in helping to make societies stable and durable. The two are obviously closely related. It is impossible to measure objectively the comparative psychological satisfactions that are gained by people within and outside of family contexts. There are so many variables, most of which lie in the social and economic settings within which families operate. One major factor is how hard it is to make a family a functioning and cohesive unit within the surrounding society. If the conditions of the milieu strongly discourage the possibility of a family's functioning as a cohesive unit, the satisfactions gained can hardly avoid being low and the price people are willing to pay for the marginal satisfactions that come from noncohesive families—both in dollars and in forgone alternative satisfactions—will be correspondingly low. Lower marriage rates, higher divorce rates, deliberately childless marriages, and subreplacement fertility rates are, in some degree, indicators of lessening psychological satisfaction derived from the institution of the family. They may also be indicators that society has thoughtlessly created conditions that frustrate the opportunity of people to have and to cherish cohesive families.

Social policy in the United States has rarely been designed to promote family cohesion. Quite the reverse. One of the most disgraceful chapters in the history of American social policy was the inadvertent creation and thoughtless perpetuations of a Federal-state welfare program that contained powerful pressures toward the breakup of destitute families. Daniel Patrick Moynihan has been especially critical of such schemes. Farm policies, too, were just as callous to the values inherent in cohesive families. The family farm was treated as having no other value than that of a production unit, and if it could not make its way in competition with highly capitalized industrial farms, its members had no choice but to migrate to cities and try to adjust. The centrifugal effect of low-cost energy and high-cost equipment on millions of farm families in this country is incalculable. The creation of the highway trust fund, although hardly anybody foresaw it at the time, also turned out to be an extremely destructive influence on the institution of the family and the viability of the city neighborhood, with its stimulation of suburbanization.

THE EFFECT OF HIGH-ENERGY USE ON THE COMMUNITY

The second building block of all earlier societies—the community—was, like the family, cast into the high-speed centrifuge of modernization and spun to its perimeter. Community is used here to mean a group of people with cohesion growing from a common bond to a place, a common pride in it, and group loyalty stemming from familiarity with and substantial trust of each other. Thus the concept of community is meant to apply to groups of people who live in a sufficiently circumscribed area so that each recognizes by sight and knows the names of most of the others he sees each day within that area and feels that he knows or has some meaningful access to the leaders of the community and role in it. By this definition, a small proportion of Americans live in communities, while a large proportion of the people of China live in communities. (This is not to suggest that the type of communities the Chinese live in would be suitable for Americans.) How important communities are to the fulfillment of the psychological needs of people and to the stability and durability of societies is a matter to which insufficient attention has been given. There may well be such wide variation between cultures and between individuals within the same culture as to make generalizations of little validity and value. Nevertheless, speculation is useful.

The community and its partial urban substitute, the neighborhood, have, over the years, served affirmative psychological as well as economic and protective purposes. They establish human connections with other people who have roots in the unique place in which they live and from which they take psychic nourishment. Those associations develop into varying degrees of trust and affection and frequently of unspoken loyalty to the common bond and humanity of the group. Membership in a genuine community has a strong tendency to enlarge the capacity of each member for accepting and extending mutual trust. In this sense, it provides a depth of meaning to life that is difficult to obtain by any substitute means. When trust is extended, so too is responsibilty. Some people, of course, in any environment, shrink from both trust and responsibility; the more inhospitable the environment, the greater the proportion of such people.

The community and the neighborhood also provide a source and form of security. People look out for one another. If they see strangers doing unusual things, they become suspicious and usually take whatever protective action seems called for under the circumstances. If a lone individual falls sick or is injured, his neighbors come to his aid. If a family has a catastrophe, the community pitches in and helps. Such mutual support is the essence of community or neighborhood.

The use of ever larger amounts of energy has the unfortunate effect of diminishing both the affirmative and the protective aspects of the community and the neighborhood. Even without the automobile, an affluent, high-energy society—dependent on trains, buses, and jets for transport, living in high-rise apartments, fed by an agricultural industry that uses large amounts of energy but employs only 5 percent of the work force—would have difficulty preserving the cohesive force of the community or the neighborhood. If little conscious realization existed of the importance of these institutions, and social policy, were not specifically designed to preserve and enhance them, the general tendency would be toward their dissolution.

When the economics of land costs, construction, and maintenance drive builders and housing authorities to erect high-rise structures, the effect is to make neighborhoods more difficult and neighborhoods less viable. It is immensely more difficult for people to be neighborly when they live in high-rise apartments than when they live close to the ground and more about horizontally and conspicuously on their own two feet rather than vertically in self-operated elevators. High-rise apartments also diminish the inclination of people to take responsibility for each other because of the sheer numbers involved. Residents may get to know a few other people in the building, but the bigger and taller the structure, the less likely they are to have any feeling of roots in the place or loyalty to its inhabitants. An anonymous vertical city is substituted for a horizontal association of people who recognize each other and develop some sense of trust and loyalty toward each other, a feeling of belonging.

THE PLACEMENT OF THE AUTOMOBILE AT THE CENTER OF SOCIETY

Each step toward urbanization, suburbanization, and exurbanization has been accompanied by an increase in dependence on energy and an escalation in its consumption. Different methods of using energy have different degrees of centrifugal force upon communities and neighborhoods. The automobile heads the list both in terms of the amount of energy consumed and as an agent of demolition of community.

In a perceptive book entitled *Energy and Equity* (1974), Ivan Illich discusses the use of energy to enable people to move from one place to another. He uses the word "transit" to mean those movements that put human metabolic energy to use, and the word "transport" to cover the mode of movement that puts other forms of energy to use. Transit applies principally to walking and bicycling, transport to whatever mechanized modes may be widely used. So far as the United States is concerned, transport means primarily the automobile.

At the rates and range of movement that are possible in walking or riding bicycles, people are relatively equal, friendly, and communicative. Their movement is also highly efficient in the use of energy, and best of all, the cost is low in terms of time and money. In contrast, Illich paints this picture of the use of time and energy in the American automobile culture:

> The typical American male devotes more than 1,600 hours a year to his car. He sits in it while it goes and while it stands idling. He parks it and searches for it. He earns the money to put down on it and to meet the monthly install-

> ments. He works to pay for petrol, tolls, insurance, taxes, and tickets. He spends four of his sixteen waking hours on the road or gathering his resources for it. And this figure does not take into account the time consumed by other activities dictated by transport: time spent in hospitals, traffic courts, and garages; time spent watching automobile commercials or attending consumer education meetings to improve the quality of the next buy. The model American puts in 1,600 hours to get 7,500 miles: less than five miles per hour. In countries deprived of a transportation industry, people manage to do the same, walking wherever they want to go, and they allocate only 3 to 8 percent of their society's time budget to traffic instead of 28 percent. What distinguishes the traffic in rich countries from the traffic in poor countries is not more mileage per hour of lifetime for the majority, but more hours of compulsory consumption of high doses of energy, packaged and unequally distributed by the transportation industry.

The automobile culture determines the configuration of social space, breaking up communities and urban neighborhoods; the more rapidly people can be transported from one place to another, the more economically insupportable neighborhoods become. Neighborhood shops and services become scarce, often nonexistent—a sure sign of the decline and perhaps imminent disappearance of the neighborhood. Traffic arteries split neighborhoods apart, and high volume, low margin shopping centers make neighborhood shops nonviable. The further one can travel in an hour's time, the greater the impetus of huge retail corporations to achieve economies of scale and provide services on a mass, impersonal, non-neighborhood basis.

Ivan Illich's greatest hope is that the combination of walking and bicycling, in conjunction with whatever mass transport may be required, will permit a "social restructuring of space that offers each person the constantly renewed experience that the centre of the world is where he stands, walks, and lives." Bicycles permit great flexibility of movement, the ultimate in efficiency, and the means of healthy exercise. Walking is in many ways superior to bicycling—it completely removes people from dependence on any mechanical contrivance and is the ultimate in flexibility—but the feasible radius of transit is more limited. In any event, it is not necessary to opt for walking or bicycling as a general mode of transit: each can be used to fit the need of the occasion.

In a tract entitled *Autokind v. Mankind* (1971), Kenneth R. Schneider picked up and expanded upon a set of concerns expounded earlier by Lewis Mumford. Schneider coined the word "automobility" to describe the uniquely American dependence on the automobile for basic mobility:

> Automobility—particularly in cities—entrenches itself in concrete, monopolizes movement, then congeals it, makes every roadway a barricade, reduces choice, hogs resources, increases costs, ravages the landscape, endangers and oppresses the pedestrian, boxes and deforms the body, contaminates the breath of life, enrages the ears, insults the eyes, makes an automaton of the nervous system, puts every citizen nearer the clutches of the law, denies casual association, rigorizes organization, distorts the public purpose, and dulls human sensibilities. Oh yes, and it kills half a million people each decade and maims millions more.

Overdrawn and caustic though it may be, such a critical characterization of what the automobile has done to both people and their social institutions is substantially deserved. To make a balanced evaluation of the automobile's costs and benefits, one would have to list its notable contributions so that they might be fairly compared with this heap of "disamenities" (only an Englishman like the economist Ezra

Mishan would think to apply such an understated term to such angry complaints, but he is one of the few economists who has not accepted the automobile as a self-evident contribution to human progress). These would include: democratizing the exhilaration of power and speed; the opportunity to travel and thereby be broadened (the boom that Francis Bacon thought would flow automatically from travel—but that was before hundreds of millions of people came to be manic and competitive travelers); a more flexible means than mass transit of transporting people from a place where they are to another place they would rather be; and the chance to economize by buying things in large quantities in supermarkets. Other items could be added to the list, but still when it is weighed against Schneider's indictment, one can only conclude that the impetus that has propelled the automobile to the center of American society, converting the human to an automan, is in no sense rational; it is the sheer magnetism of power, speed, and mobility.

Rational or irrational, our society has now been structured in such a way that the automobile is indispensable to most people. With few exceptions, most new construction in the last quarter-century outside of New York City has been built on the assumption that people would be transported to or from the new buildings by automobile. A person without an automobile—a person who wishes to move about by walking and by public transportation—is tantamount to a cripple. The environment has been consciously designed and constructed around the automobile; people are clearly secondary. Amazingly, as Schneider points out, the United States has built a society in which one cannot drink without driving—that is, most of the sociable drinking that occurs requires most drinkers to drive home afterward. Is it any wonder that our automobile accident rate is so high? Schneider is no less interested than Illich in the social restructuring of space to put human beings back at the center and restore the use of their feet.

The American love affair with the automobile has been so ardent that most of its devotees have been disposed to ignore its inequities. The killing of fifty to sixty thousand people a year and the injury of some four million more seems to most people a tolerable price to pay for a couple of hundred horses in their garage, ready to leap into action at their command. The fact that the totality of highway deaths has exceeded American fatalities in all wars, and that injuries vastly exceed war casualties apparently does not disturb them. The spewing of more pollution than all industry combined seems of minor concern. That automobiles choke cities and foul the countryside with trash, junked cars, and neon signs is unfortunate, to be sure, but seemingly just another cost and by-product of progress. But we can hardly ignore the facts that they engender disrespect for law (rare is the driver who does not violate speed limits when he thinks he can get away with it), clog the courts to such a degree that judicial decisions are delayed interminably, thus frustrating one of the most important purposes of the judicial process, and entice juveniles into theft and adults into going into debt over their heads.

On any given amount of paved street or highway, the more cars, obviously, the more likelihood of a traffic jam, and the more speed, the more likelihood of collisions, casualties and fatalities. With the drivers of a hundred million automobiles trying to transport themselves somewhere else as expeditiously as possible, a kinetic crowdedness (that is, having one's movements constrained by others competing to occupy the same space) is created that far exceeds that in a much denser, slower-moving non-automotive society. Studies of the effects of crowdedness on the human psyche and soma are only in their infancy, but when they become more sophisticated they will probably reveal that the American automobile culture creates a greater sense of crowdedness than is felt by many of the citizens of China and India whose physical density is much greater. Such psychological tension cannot fail to have adverse social and physical effects.

ENOUGH IS TOO MUCH

In a widely anthologized essay entitled "The Tragedy of the Commons," the biologist Garret Hardin called attention most persuasively to the adverse social effect caused when herdsmen who make use of open and commonly held pasture for grazing their cattle, raise so many cows that the common pasture is overgrazed and the capacity of the land to feed the herds collapses. Hardin develops an analogy with human populations that may not be entirely valid but is useful in relation to the automobile population of the United States. There is a certain threshold up to which additional cows or cars do not seem to do any great harm to the common area within which each may roam. Beyond that point, however, the capacity of the land is overstrained and additional units have a strongly negative effect. Yet no single individual is constrained thereby to cut back on his number of cows or cars in the interest of other users of the commons, since cutting back on his own use of the commonly held space injures him and aids others. Why, therefore, should he do it? Hardin concludes that the only conceivable answer to this difficult problem is "mutual coercion, mutually arrived at." That, of course, is what government is all about. But in a society that operates through representative government and the consent of the governed, the only way that such mutual coercion can be achieved is for the body politic to become sufficiently convinced of the imperative nature, or at least the desirability, of laws and penalties as applied to themselves as well as others, that they are willing to have such coercion universally applied.

The national park system is an example of the commons of which Hardin speaks. A half-century ago, the magnificent Western parks were the Mecca for a limited number of nature lovers, but with the democratizing effects of the automobile the parks came within reach of the average American. Picture, then, the teenage girl who had seen Yellowstone and Yosemite after a transcontinental trek in the 1920s and vowed that when she had a family of her own she would bring them to see this greatest of natural wonders. Three decades later, she piled her four teenage children into a station wagon and headed West. When she arrived at the grandest of the grand sights, as she thought of Yosemite, the family was caught in a traffic jam, competing with some 40,000 other people who wanted to share the same inspiration. They spent hours, bumper to bumper, inching along or not moving at all for long periods. The family became restless, annoyed, and tired.

What was to have been a supreme life experience turned out to be a disappointment. Yellowstone was not quite so bad, but it, too, was seriously overcrowded. The proliferation of the automobile had degraded the best parks.

The jets have visited upon much of the world what the automobile has inflicted upon the choicest natural areas and historical and cultural spots of the United States. Transporting and disgorging millions of tourists around the globe, the jets have brought commercializing and homogenizing influences to bear on the tastes and hostelry of the people of exotic lands, persuading the placid, noncompetitive Fiji Islanders, and millions of others, that their culture is backward and that they should modernize—but keep just enough of the old ways to attract tourists. Tourists now overrun natural and cultural landmarks on all continents, vulgarizing many areas.

In recent years, about two million people a year have been touring the Acropolis to view what remains of the Garden of Eden of Western thought and culture. They have so eroded the steps of the Propylaea that planking has been installed as an emergency measure. The same is happening to the Parthenon. In a variety of other ways, the overwhelming tourist traffic is degrading the Acropolis. "Tourism is good to a certain point," said Dr. George Dontas, Director of the Acropolis Museum. "Then it becomes a plague." It seems obvious to him and to others that that point has been reached and passed. The problem is how to bring matters under control. In dozens of ways, the jet age has carried the automobile age one step further in reducing the diversity and interest of the multiple cultures of the earth.

Thus we see the basic paradox of affluence: Enough for everybody turns out to be too much for anybody. If the world were to become steadily more affluent, with more and more disposable income available to be spent on travel, the world would become vastly more homogenized and uninteresting and the very purpose for which affluence was presumably intended would be defeated. The natural and cultural environments would be degraded beyond recognition, and, worst of all, so would be the people who expected to be enriched by travel.

As in the case of so many other matters in the physical world, there is a threshold effect here. We may be approaching the threshold at which disenchantment with international travel exceeds its enchantment. That point will, of course, vary widely between countries, with greater travel still ahead to selected countries where pleasure still outweighs discomfort, but in some others—especially those where crime, hijacking, begging, and anti-Americanism flourish—international tourism by Americans may already have passed its peak. In any event, it seems rather clear to anyone who examines recent trends that international air travel cannot regain its earlier accelerative thrust in the foreseeable future. High costs are, of course, an important factor, but kinetic crowdedness is taking a major toll.

"KICKING" THE AMERICAN ADDICTION TO THE AUTOMOBILE

Five years ago, one would have said that there was no reasonable possibility that Americans would have any interest during this century in "kicking" their overwhelming addiction to the automobile.

But today, the prospect that Americans may take major steps in the next decade—certainly before the year 2000—to bring their dependency under manageable control appears substantially greater. The OPEC countries suddenly made the habit annoyingly expensive, but that is not the only stimulus to change. As described earlier, large numbers of people are finding driving less and less enjoyable under the conditions that require them to contend and compete with traffic at both ends of the day and at other times as well. Their bodies are deteriorating for lack of exercise and their tempers and nerves are deteriorating from too much exercise. They are becoming psychologically ready to reduce their dependence on the automobile, but it will not be easy.

Society conspires against the person who wants to free himself or herself from the automobile habit to a greater degree than it frustrates the smoker who decides to become a nonsmoker, for he is actively discouraged from doing so by public policies that overwhelmingly favor the automobile. The difficulties and dangers of riding a bicycle on main traffic arteries during rush hours make it imprudent for most people even to consider it. Even the few hardy souls that do face the problem of parking their bicycles in places where they will not be stolen. It is quite apparent that the automobile has hogged the streets. Does this mean that those who wish to will never be able to buck the automobile, that there is no way of kicking the automobile habit? Almost, but not quite.

In 1973, more than 16 million bicycles were bought—5 million more than the number of automobiles; in 1974, the bicycle sales continued to exceed those for automobiles. The American love affair with the 10-speed bicycle had begun to warm up at the very time that its enchantment with the automobile was obviously cooling. Bicyclists are probably already sufficiently numerous to have it within their power to obtain enactment of city ordinances and other legislation that will help them alter the transit mores of the society. If not, they soon will be. The creation of one-way bicycle streets during rush hours, as in Holland, the creation of systems of parking bicycles in protective custody at key points, including commuter train stations, and similar encouragements to the use of bicycles seem likely to develop in many U.S. cities and thus begin a gradual change in transit systems and habits.

Despite the lack of comprehension and support of Midwestern and Mountain state Congressmen for Federal aid for urban mass transit systems, it seems predictable that as the price of gasoline rises and as the deterioration of core cities becomes a matter of unavoidable national concern, the mass transit systems will cry out so loudly for modernization and operating subsidies that a reversal of the long degenerative process of these systems will slowly begin. The rebuilding of mass transit will be a long, slow process, but there is a certain inevitability about it as a public policy, for without it some cities—especially New York—would decline in a manner and to a degree the nation could not tolerate.

Slowly, a significant shift is occurring in a variety of public policies that should demote the automobile from its role at the center of society. Without the sudden jump in the cost of oil, and the sudden re-education of the American people concerning the future availability of oil and gas, and all the implications that flow from such abrupt changes, this lessening in importance of the automobile would have seemed unlikely in the foreseeable future. But with the end of cheap gasoline as a permanent fact of life came the real probability of a basic change in our automobile society. Smaller automobiles will gradually replace the 200–400 horsepower models, cars will sooner or later be built to last longer, and gradually new residential and commercial construction will be adjusted to appeal to people who choose to live without owning an automobile, renting a car for the limited number of occasions when it becomes indispensable. This may be an integral part of a major shift in the direction and values of American society. Needless to say, it will not be at all easy to make the kinds of adjustments required in the pattern of skills and employment of persons whose livelihoods depend directly and indirectly upon the automobile industry.

Reason, as we know, is slow to take effect in coping with an addiction. When external circumstances alter in such a way as to reinforce reason, change may come more rapidly than one would otherwise expect. The fundamental alteration in the world's petroleum market is just such an external factor.

THE COMING TRANSFORMATION

(By Willis W. Harman)*

Let me first be explicit with regard to the magnitude and pervasiveness of the transformation being posited. This is thoroughgoing systemic change, comparable in importance to such transitions as the prehistoric change from a hunting and gathering to an agricultural society or the industrial revolution. Such a systemic change involves a metamorphosis in basic cultural premises, fundamental value premises, the root image of man-in-society, and all aspects of social roles and institutions.

Our research leads me to the conclusion that *the industrialized world is simultaneously undergoing a conceptual revolution as thoroughgoing in its effects as the Copernican Revolution, and an institutional revolution as profound as the Industrial Revolution.*

Furthermore, this overall transformation is proceeding with extreme rapidity, such that the most critical period will be passed through within a decade. Whether the social structure can withstand the strain is very much at issue, and this will greatly depend on how well we can understand the nature and necessity of the transformation while we are experiencing it.

In *The Transformations of Man* (1956), Lewis Mumford notes that there have probably been not more than a half dozen profound transformations in Western society since primitive man. Here we are talking about a rare type of event, and we can only make, at best, an informed guess concerning the character of the new type of social paradigm that will succeed the industrial society we have known. But the consequences of such a transformation are so profound that we cannot afford to disregard the signs that it may occur.

SIGNS OF TRANSFORMATION

There are three major reasons why a transformation, though rare, historically, is now plausible:

First, the complex of social problems confronting the developed world appears to require changes in cultural values for their satisfactory resolution. The societal dilemmas (discussed in my previous article) appear to be unresolvable within the currrent paradigm, and are creating pressure for a shift in that paradigm. In *The Structure of Scientific Revolutions*, Thomas S. Kuhn vividly describes how scientific paradigms are replaced: A watershed point is reached where the accumulated weight of discrepancies and anomalies that cannot be fitted into the old paradigm tips the balance, and scientists find it more profitable (in emotional as well as rational terms) to seek a new paradigm than to patch up the old.

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*From The Futurist, April 1977, p. 106-112, published by the World Future Society. This is the second of a two-part article which begins in the February 1977 issue. Willis Harman is Association Director with the Center for the Study of Social Policy at Sanford Research Institute. Reprinted by permission.

Second, various "lead indicators" that have preceded other periods of historic cultural change have been prominent during the last decade. Studies of revolutionary cultural and political changes through history suggest certain typical occurrences tend to appear one to three decades ahead of the central change. These advance indicators include:

Decreased sense of community.

Increased sense of alienation and purposelessness.

Increased frequency of personal disorders and mental illness.

Inncreased rate of violent crime.

Increased frequency and severity of social disruptions.

Increased use of police to control behavior.

Increased public acceptance of hedonistic behavior (particularly sexual), of symbols of degradation, and of lax public morality.

Increased interest in noninstitutionalized religious activities (e.g., cults, rituals, secret practices).

Signs of specific and conscious anxiety about the future.

In some cases, economic inflation.

(The news stories of the past decade suggest that these advance indicators may be observed in today's society.)

Furthermore, as Kuhn points out, a conscious challenge to an operative system in itself constitutes another lead indicator. The legitimacy of a social system and its distribution of power is based on three assumptions: that the system has been duly constituted, that it adheres to adequate guiding moral principles, and that it is effective in achieving its agreed-upon goals.

All these assumptions now are challenged. The first challenge is to the assumption that industrial society is duly constituted. Though the governments of the industrialized democracies may meet the challenge, there exist other concentrations of power that do not. These include the large multinational corporations and the world economic system as a whole. As the largest corporations begin to wield influences over human lives that are comparable to those of governments, they face a demand that has, historically, been made only of government—that they assume responsibility for the welfare of those over whom they wield power. People who currently feel themselves to be disenfranchised include members of nonindustrialized cultures, minorities, consumers, youth, the aging, women, and those who are physically handicapped.

The dominant scientific-technological establishments are being challenged as arbiters of truth, because they are dominated by the values of industrialism and promote the industrial system first and human beings second.

The second challenge is to the morality of the system. Critics argue that the industrial system is not guided by adequate moral principles, particularly with regard to the equity of distribution of the earth's resources. Economic incentives predominate over everything. There is no effective ethic or mechanism for redistribution, nor is there any effective ecological (in the broad sense) ethic. The sense of pride in striving toward noble goals seems clearly to be dwindling. There are no adequate goals, beyond self-interest, to enlist the deepest loyalties and commitments of citizens.

The third and last challenge relates directly to the dilemmas of the industrial system: The system does not foster the enhancement of the total environment. There is a shortage of satisfying work roles. Incentive structures fail to insure the welfare of future generations, especially with regard to their need for fossil fuels, mineral resources, arable land, natural fresh water, and a fruitful ocean. The system does not promote socially responsible management of the impacts of new technological applications.

THE EMERGENT PARADIGM

Third, a competitor to the industrial-state paradigm—a model that embodies the requisite kinds of value shifts—appears to be arising. This emergent paradigm also helps to make a societal transformation seem plausible.

The shape of the future will no more be patterned after the hippie movement and the New Left philosophies than the Industrial Age could have been inferred from the "new age" values of the Anabaptists. But several signs point to the possible emergence of a new dominant paradigm:

1. Surveys and polls by Daniel Yankelovich and others indicate significant value shifts among certain elite groups, such as students and corporate executives, toward an increased emphasis on humanistic, spiritual, quality-of-life, community, and similar values, and a decreased emphasis on materialistic values, status goals, and unqualified economic growth.

2. Numerous cultural indicators, including the themes of recent books, plays and motion pictures, the goals and types of voluntary associations, rock music lyrics, contents of magazine articles, and elements of the "new age" subculture, show greatly increased interest in and tolerance for the transcendental, religious, esoteric, occult, suprarational, mystical, and spiritual.

3. New scientific interest in exploring subjective and altered states of consciousness, due in part to the discovery of numerous physical and physiological correlates to inner experience—rapid-eye-movement, galvanic skin response, muscle tensions, electroencephalographic (EEG) components, body electric and magnetic field components, biofeedback signals—is resulting in a new legitimation of studies of religious beliefs, mystical experiences, meditative states, psychic phenomena, and occult mysteries.

From these indicators, particularly the last, we can infer something about the direction in which values, and the dominant image of man-in-the-universe, are likely to shift. Whenever the nature of man has been probed deeply, in both Eastern and Western traditions, the paramount fact emerging is the duality of his experience. He is found to be both physical and spiritual, with both aspects being "real" and neither fully describable in terms of the other. A fundamental characteristic of the paradigm that may be emerging is the complementarity that the paradigm gives to such currently troublesome opposites as spirit/body, science/religion, and determinism/free will. Complementarity enabled modern physics to reconcile the wave and particle metaphors for light, so that neither theory contradicts the other.

I suggest the following characteristics could emerge as a post-transformation paradigm:

> Complementarity of physical and spiritual experience; recognition of all "explanation" as only metaphor; use of differinng, noncontradictory "levels of explanation" for physical, biological, mental, and spiritual reality.
>
> Teleological sense of life and evolution as having direction/purpose; ultimate reality perceived as unitary, with transcendent order.
>
> Basis for value postulates discoverable in one's own inner experience of a hierarchy of "levels of consciousness"; potentiality of supraconscious as well as subconscious experience.
>
> Goals of life: aware participation in individual growth and the evolutionary process; individual fulfillment through community; integration of work, play, and growth.
>
> Goals of society: to foster development of individuals' transcendent and emergent potentialities; economic growth, technological development, design of work roles and environments, authority structures, and social institutions are all to be used in the service of this primary goal.
>
> "New naturalism, holism, immanentism" (Victor Ferkiss); "Re-discovery of the supernatural" (Peter L. Berger); "The counterculture is essentially an exploration of the politics of consciousness" (Theodore Roszak).

Thus the challenging paradigm assumes some sort of transcendent spiritual order, discoverable in human experience, against which human value choices are assessed. Ultimately, reality is unitary, and life and evolution have direction or purpose. Levels of consciousness are explorable, with different appropriate levels of explanation. Hence the scientific explanation of the level of sensory experience in no way contradicts religious, philosophical, or poetical interpretations of suprasensory experience. Rather, it is complementary to them.

The candidate paradigm extends rather than contradicts the modern scientific world view, much as relatively theory extended Newtonian mechanims: the latter is merely a special case and none-the-less useful in the appropriate circumstances.

THE PERENNIAL PHILOSOPHY

Moreover, the candidate paradigm is in its essence not new at all. It has formed a major stream of thought in the humanities, in Western political tradition, in "transcendentalist" movements in U.S. history, and in the major religious philosophies throughout history. However, never has anything like it been the guiding paradigm of an entire society.

Aldous Huxley, in *The Perennial Philosophy* (1945), was one of the first modern writers to suggest that this age-old set of basic assumptions about the nature of man was showing new strength. He described it as: "the metaphysic that recognizes a divine Reality substantial to the world of things and lives and minds; the psychology that finds in the soul something similar to, or even identical with, divine Reality; the ethic that places man's final end in the knowledge of the imminent and transcendent Ground of all being . . . Rudiments of the Perennial Philosophy may be found among the traditional lore of primitive peoples in every region of the world, and in its fully developed forms it has a place in every one of the higher religions. A version of this Highest Common Factor in all preceding and subsequent theologies was first committed to writing more than twenty-five centuries ago, and since that time the inexhaustible theme has been treated again and again, from the standpoint of every religious tradition and in all the principal languages of Asia and Europe."

The perennial philosophy forms an intermittently visible stream which has had a profound effect on Western civilization. Thales, Solon, Pythagoras, and Plato journeyed to Egypt to be initiated into it mysteries, ancient even then. Much of it is woven into institutionalized Christianity. In its Hermetic, Cabbalistic, Sufistic, and Rosicrucian forms it affected the history of the Middle East and of Europe. Through the traditions of Freemasonry, its symbols were incorporated into the Great Seal of the United States, testifying to its influence on forming many of the national goals to which we still adhere. It also appears in the Transcendentalism of Emerson, the Creative Evolution of Bergson, and the writings of William James, Mohandas Gandhi, St. Francis of Assisi, and Lao Tse.

Hints of its flavor, but only the flavor, can be given in the following five statements:

Being.—Under certain conditions man can attain a higher awareness, a "cosmic consciousness," in which he experiences the reality underlying the phenomenal world. In speaking of this reality, it seems appropriate to use such words as infinite, eternal, the Divine Ground of Being, Brahman, and God. From this vantage point, a person's own growth, creativity, and participation in the evolutionary process are seen to be under the ultimate direction of a higher center (Atman, the higher Self, the Oversoul).

Awareness.—A man goes through life in a sort of hypnotic sleep, feeling that he is making decisions, having accidents happen to him, meeting chance acquaintances, and so forth. But with more awareness, the supraconscious choosing, the direction of the higher Self, becomes apparent. The person finds that the decisions he felt he had come to logically or through intuition were really reflections of choices made on the higher level of the Self; that his "inspiration" or "creativity" is essentially a breaking through of these higher processes; that experiences and relationships which he needed for his growth were attracted to him by the Self and were not as accidental as he had assumed. Because ordinary perception, compared to this higher awareness, is partial perception, language built up from ordinary perception proves inadequate to describe the greater reality; attempts often are paradoxical in form.

Motivation.—Increasing awareness reduces the pull of material and ego needs, and the person finds his deepest desire is to participate fully in the evolutionary process, achieving wholeness (haleness, health) through alignment of supraconscious, conscious, and subconscious choices. Evolution is seen to be directed by a higher consciousness and characterized by purpose.

Potentiality.—It follows from the foregoing that the human potentiality is limitless; that all knowledge and power is ultimately accessible to the mind, looking within itself; and that all limitations (infirmities, illnesses, etc.) are ultmately self-chosen.

Attitude.—With awareness comes a new attitude toward life. One aspect of this new attitude is a desire to labor, serve, and participate consciously in the evolutionary process, the cosmic drama, the fulfillment of mankind. But the reverse side is the conscious acceptance of what is, since at a deep level of the self one has already chosen this. Related to this acceptance of reality is a certain nonattachment to everyday events, or at least being deattached from specific outcomes.

SOURCES OF SUSPICION

Modern Western man is suspicious of such a transcendental outlook for three reasons: (1) Unlike modern science, the transcendental outlook does not seem to be based on public perceptions; (2) attempts to communicate about it often sound dangerously close to superstitious nonsense; and (3) the transcendental outlook seems to connote quietistic retreat from the problems of the world.

The first objection is gradually being countered by science itself: Scientists are finding that the division between subjective and objective, observer and observed, is nowhere near so clearcut as had been assumed in the early naive period of the science-versus-religion debates. The deep-rooted attitudes and prejudices of the observer have been shown to affect his observations. The problem of what knowledge is public, universal, and therefore "true" permeates all of science, being more obviously troublesome in some fields than in others. To overcome subjective influences, it has long been a standard practice when testing new medicines to conduct "double blind" experiments in which neither the subject nor the experimental personnel know whether the drug or a placebo has been administered.

The second ground for suspicion—poor communicability—is fundamental. Language and metaphors built up from ordinary, partial perception prove inadequate to describe the expanded view of reality and are frequently mystifying. Witness this statement from the *Upanishads*, an ancient Hindu treatise: "An invisible and subtle essence is the spirit of the whole universe. That is reality. That is truth. Thou art that."

As to the third objection, some versions of the perennial philosophy do indeed sound like a quietistic retreat, at least in their Western forms. But a central concern of many of these versions, including [illegible] Masonic tradition, is the development of the knowledge by which humanity can achieve a state of mutual understanding and spiritual integrity. Work is placed at the heart of humane living—not a compulsive Protestant work ethic, nor work for economic gain, but the joy of vital and creative work.

Yet part of the growing acceptability of the "new age" world view undoubtedly has been due to its ability to draw on what has already been well-established in the culture. The perennial philosophy also bridges the gap between the "two cultures" of the sciences and humanities.

TWO GUIDING ETHICS

Growing out of this image of man as a transcendent being come a pair of complementary ethics which are most congruent with the kind of transformation necessary for the resolution of contemporary societal dilemmas. The first is an ecological ethic and the second a self-realization ethic.

The ecological ethic, as defined by Lynton Caldwell (*Environment: A Challenge to Modern Society*, 1972) recognizes the limited nature of resources, sees man as an integral part of the natural world, hence inseparable from its governing processes and laws. The ecological ethic fosters a sense of the total community of man and responsibility for the fate of the planet, and relates self-interest to the interests of fellow man and of future generations.

A "self-realization ethic" asserts that the proper end of all individual experience is the further development of the emergent self and of the human species. The appropriate function of *all* social institutions is to create an environment which will foster that process. The self-realization ethic would push society toward a restructuring of social institutions to satisfy the individual's need for full participation in the society. As corollaries to this ethic, self-determination of individuals and minority groups should be fostered, social decision-making should be highly decentralized, and the mechanism of a strong free-enterprise private sector should be preferred over public bureaucracy for the accomplishment of most social tasks.

These two ethics—one emphasizing the total community of man-in-nature and the oneness of the human race, and the other placing the highest value on the development of selfhood—are complementary, not contradictory. Together they encourage both cooperation and wholesome competition, both love and individuality. Each is a corrective against the excesses and misapplications of the other.

THE TRANSITION PERIOD

There is nothing in history to suggest that a social transformation of the magnitude suggested could occur without the most severe economic and social disruptions and systems breakdowns. If we are indeed involved with a shifting social paradigm, it follows that the main challenge to society is to bring about the transition without shaking itself apart. Actions which attempt to force the change too quickly can be socially disruptive; actions which attempt to hold it back can make the transition more difficult and perhaps bloody. Seldom in history has such delicacy of balance been required.

On the other hand, this description of a macroproblem should not be interpreted as a counsel of despair, that nothing worthwhile can be done short of some "macrosolution." It does not follow that a global problem necessitates a global solution. On the contrary, we have heard enough over the last four decades of plans for near-utopian societies to justify our considerable disenchantment with "grand designs."

What is now needed is a radical vision with adaptive incremental strategies. But these strategies need to be coordinated through widespread understanding of the interrelatedness of the separate actions.

The radical vision is not lacking—it was present at the founding of the nation and presumably has not been repudiated. The report of the President's Committee on National Goals, *Goals for Americans* (1960), included such statements as:

> The Declaration (of Independence) put the individual squarely at the center, as of supreme importance. It completely reversed the age-old order; it defined government as the servant of the individual, not his master.
>
> The paramount goal (of the nation) is to guard the rights of the individual, to ensure his development, and to enlarge his opportunity.
>
> All of our institutions—political, social, economic—must further enhance the dignity of the citizen, promote the maximum development of his capabilities, stimulate their responsible exercise, and widen the range and effectiveness of opportunities for individual choice.

But belief in this vision has diminished, only partly because of natural cynicism and institutional failure to live up to the goals. More importantly, it is because the basis for belief has been eroded by the striking practical successes of positivistic science. Thus the most fundamental conflict of all is that the most scientifically sophisticated image of man available has led us to the prospect of Jose Delgado's "psychocivilized society," where the right behavior is to be induced in persons through operant conditioning or through electric signals introduced into the brain, and has led us to be admonished by B. F. Skinner that notions of freedom and dignity are romantic delusions of a prescientific culture.

Several recent scholars of the future such as Robert Heilbroner, Kenneth Boulding, and Fred Polak have made much of the concept that it is the *image* of the future which is the key to that future coming into realization. "Every society," said Polak, "has an image of the future which is its real dynamic." Another way to state this is that every society has some "central project," an overall task or central goal toward which it dedicates its time and energy.

Ever-increasing material consumption and waste is no longer an adequate central project for industrial society. A society-wide self-realization ethic, coupled with a major scientific investigation of the transcendental aspects of reality, may provide an adequate substitute. With the growing realization among scientists that science does not deal with ultimate reality, but with models and metaphors, we now have a more promising climate for the exploration of inner experience.

ADAPTIVE STRATEGIES

If we are to undergo this kind of transition without tearing ourselves apart in the process, we will need to implement strategies which will allow us to adapt ourselves and our society gradually to the exigencies of a post-industrial society.

Rather than present a host of proposals for all sectors of society, let me touch a couple of areas.

Global thinking, attention to future consequences, and concern for fellow man and future generations need to enter into local and immediate decision-making. A variety of institutional changes could foster this kind of widespread citizen participation in "designing the future." This kind of participation is one of the most powerful ways of encouraging the choosing of socially responsible behavior, as opposed to imposing necessary constraints through governmental regulation. In addition, learning and planning are the two main forms of work which can absorb unlimited numbers of people when only some people, with only a fraction of their time, are needed to produce all the goods and services the society can use.

Many of these same institutions could also achieve the necessary regulation of political, social, and economic affairs at the lowest practicable level—which may be the local community for human-welfare issues and the planetary level for oceanic pollution.

The complexity and interrelatedness of these tasks demands a well-coordinated network of planning units at local, regional, national, and planetary levels. In general, these units would have two tasks: the definition and comparison of alternatives, and the selection and actualization of the alternative to be followed. The first task is technical, requiring advanced skills and detailed information. The second is political, involving citizen participation, stimulation of needed actions, and brokerage of the resources required from concerned organizations and agencies.

THE NEXT DECADE

The forces of societal transformation have gathered impressive momentum. The next 10 to 15 years will show whether these forces are strong enough to bring about a major societal wrenching, or whether they will somehow quiet down and die away, or whether the confrontation between the new demands and the old rigidities is so violent that the result is destruction without a promising rebuilding.

This period will not be history's most comfortable one, but it will no doubt be interesting. The industrial world badly needs a positive and inspiring image of its own future, and competent policy and leadership to guide it through what will be, at best, trying times.

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Treadway, Hamilton. The economics of energy growth. Public utilities fornightly, v. 100, Sept. 15, 1977 : 9–18.

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United States. Congressional Budget Office. Energy research, development, demonstration, and commercialization. Washington. For sale by the Supt. of Docs., U.S. Govt. Print. Off., 1974, 41 p.

" . . . discusses the R,D,D, and C, research, development, demonstration and commercialization process, criteria that can be used to judge potential energy R,D,D, and C. stratgeies, and the costs associated with various elements of such strategies."

———. Department of Energy. Fusion Power Reactor Senior Review Committee. Perspective on the development of fusion power by magnetic confinement—1977. Washington, 1977. 7 p. "DOE/ET-0002"

The Committee concludes: that recent progress of the magnetic fusion energy program provides a tangible basis for the belief that the development of fusion power will prove feasible: that the primary near-term objective of the program should now be to demonstrate actual reactor-level conditions, and that the potential long-term benefits of fusion power are sufficiently great to warrant a sustained national effort to advance the fusion power option to the stage of commercial availability at an early time.

———. Federal Power Commission. Technical Advisory Committee on the Impact of Inadequate Electric Power Supply. National power survey: the adequacy of future electric power supply, problems and policies: the report and recommendations of the Technical Advisory Committee on the Impact of Inadequate Electric Power Supply. Washington, Federal Power Commission. For sale by the Supt. of Docs., U.S. Govt. Print. Off., 1976, xv, 82 p. Cover title: The adequacy of future electric power supply. TK23.U54 1976 333.7

———. General Accounting Office. An evaluation of proposed Federal assistance for financing commercialization of emerging energy technologies, multiagency: report to the Congress by the Comptroller General of the United States. Washington, 1976, vi, 65 p. "EMD-76-10" HD9502.U52U55 1976b 338.4/7/662660973

———. The magnitude of the Federal solar energy program and the effects of different levels of funding; report of the Comptroller General of the United States. Washington, 1978. 56 p. "EMD-78-27, Feb. 2, 1978"

———. More attention should be paid to making the U.S. less vulnerable to foreign oil price and supply decisions: report to the Congress by the Comptroller General of the United States. Washington, 1978. 97 p. "EMD-78-24, Jan. 3, 1978"

An illusion of U.S. impotence has been created by U.S. policymakers' fixation on its market place weakness, rather than on its many strengths outside the trade of dollars for oil. To dissolve this fixation, it is necessary for U.S. policymakers to raise their sights above the petroleum marketplace and to recognize that the many strengths of the United States outside it are not nullified by the fact of its present dependence on foreign oil.

———. U.S. coal development—promises, uncertainties: report to the Congress by the Comptroller General of the United States. Washington, 1977. 1 v. (various pagings). "EMD-77-43, Sept. 22, 1977"

This report presents GAO's analysis of the prospects for developing America's vast coal resources. The report summarizes available knowledge on U.S. coal development, and seeks to identify the major policy issues that must be considered—especially if we are to achieve the coal production and use goals in the Administration's National Energy Plan.

University City Science Center. A challenge to action: abridged papers from the Sugarloaf Seminar on Energy Resources and Management. Sponsored by Department of Community Affairs, Governors Energy Council. . . . Prepared by University City Science Center. . . . Harrisburg, Pa., The Department, 1976. iv, 210 p. HD9502.U5U50 1976 333.7

Warne, William E., ed. The energy crunch of the late 20th century: a symposium. Public administration review, v. 35, July–Aug. 1975: 315–354.

Contains 7 articles offering glances at the problems of organizing to meet energy problems—at national, state, and local levels—at conservation and environmental interfaces, at what may be meant by a change in life style enforced by energy stringencies, and at what the 93rd Congress did and did not do about the whole matter of energy supplies.

Weidenbaum, Murray L., Reno Harnish, and James McGowen. Government credit subsidies for energy development. Washington, American Enterprise Institute for Public Policy Research, c1976. 55 p. (Energy policy; 2). HD9502.-U52W44 333.7

Weinberg, Alvin M. To breed, or not to breed? Across the Board. v. 14, Sept. 1977: 4–12, 14–24.

The United States should proceed with the development of the liquid metal fast breeder reactor "to determine once and for all how well it works, how expensive it is likely to be, and therefore whether it, rather than solar electricity or fusion, is likely to be our prime long-term source of energy."

Whalen, Richard J. The real oil crisis is still to come: we may be running out of borrowed time. Washington post, Sunday, Aug. 21, 1977: C1, C4+.

Winger, John G. and Carolyn A. Nielson. Energy, the economy and jobs. Energy report from Chase, Sept. 1976: 1–8.

In relation to the economy, the use of energy by the U.S. is not grossly wasteful; the potential benefits of energy conservation are overdrawn and the U.S. should begin to develop its own energy resources which are not in short supply.

Wonder, Edward F. Nuclear fuel and American foreign policy: multilateralization for uranium enrichment. Foreword by Henry H. Fowler. Boulder, Colo., Westview Press, 1977. 72 p. (The Atlantic Council Policy series). JX141.W66 1977 327.73

World Future Society, P.O. Box 30369, Washington, D.C. 20014

HOW TO SECURE ADDITIONAL INFORMATION ON ENERGY POLICY

1. GOVERNMENT PUBLICATIONS

Additional sources of information on energy policy in the United States are hearings and debates in the Congress and the publications of the Department of Energy; the U.S. Geological Survey; the Bureau of Mines; the U.S. Environmental Protection Agency; also the U.S. Energy and Research Development Administration and the U.S. Federal Energy Administration before 1977 when their functions were assumed by the Department of Energy.

The "Monthly Catalog of United States Government Publications," issued by the Government Printing Office, provides an index to Congressional hearings, reports, documents, and committee prints and to publications by Government agencies. Within the catalog Congressional publications are arranged by committee and the documents are in turn indexed in the back of the book by subject. If the desired documents are not available in a school or local library, they may be obtained, if still in print, by writing directly to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

The Congressional Record contains Congressional debates as well as relevant articles and speeches. Accordingly, it is a valuable source of information. It appears daily during the sessions of Congress with an index which is issued about every two weeks. At the end of a session bound volumes of The Record are published, one of which contains an index covering the complete session. The user should be alert to the fact that the pagination differs for the daily and bound editions of The Record.

2. OTHER SOURCES

Other useful sources for information are the yearly Congressional Quarterly Almanac, published since 1945, the Congressional Quarterly Weekly Report, published since 1946, C.Q.'s Congress and the Nation and its supplements, and the National Journal, published since 1969.

3. BOOKS AND PERIODICALS

In order to be aware of the latest books and magazine and newspaper articles on energy policy and power resources, the debater may wish to consult indices such as the Reader's Guide to Periodical Literature, a guide to general and non-technical periodicals; the Business Periodical Index; the Vertical File Index; the Bulletin of the Public Affairs Information Service, a subject list of the latest books, pamphlets, Government publications, reports of public and private agencies, and periodical articles, relating to economic and social conditions and public administration; The Christian Science Monitor Index; the New York Times Index; and the Wall Street Journal Index.

Most of the weekly news magazines have regular information on energy matters and the reader is urged to review major newspapers for the latest political developments.

Additional material relating to energy policy may be obtained from the following organizations:

American Gas Association, Educational Services, 1515 Wilson Boulevard, Arlington, Virginia 22209
American Petroleum Institute, 1801 K Street, N.W., Washington, D.C. 20006.
Atomic Industrial Forum, Inc., 475 Park Avenue South, New York, New York 10016
Concern, Inc., 2233 Wisconsin Avenue, Washington, D.C. 20007
Conservation Foundation, 1250 Connecticut Avenue, N.W., Washington, D.C. 20036
Edison Electric Institute, Educational Service, 90 Park Avenue, New York, New York 10016
Electrical Industries Association, 6055 East Washington Boulevard, Los Angeles, California 90040
Energy Action Committee, 1523 L Street, N.W., Washington, D.C. 20005
Energy Options EEG/EAG, 1543 North Martel Avenue, Los Angeles, California 90046
League of Women Voters, 1730 M Street, N.W., Washington, D.C. 20036
National Coal Association, Educational Division, 1130 17th Street, N.W., Washington, D.C. 20036
National Education Association, 1201 16th Street, N.W., Washington, D.C. 20036
National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009
Solar Action, 1028 Connecticut Avenue, N.W., Washington, D.C. 20036
World Future Society, P.O. Box 30369, Washington, D.C. 200114

PUBLICATIONS RELATING TO THE 1978–79 NATIONAL HIGH SCHOOL DEBATE TOPIC[1]

What Should be the Energy Policy of the United States? 1978. 534 p. 95–2:S.doc. 116; S/N 052–071–00567–6	$5.25
Analysis of the Proposed National Energy Plan, August 1977: This is a critique by the Office of Technology Assessment of the National Energy Plan originally proposed by the Carter Administration in April 1977. 1977. 243 p. il. Y 3.T 22/2:2 En 2/6; S/N 052–003–00420–8	4.00
Buying Solar: Solar energy for your home is here. Whether it will help you by producing real savings depends upon a number of factors, including where you live, the type of home you have or intend to build, the quality of insulation in your home, your present energy costs, and the type of solar system you purchase. Buying Solar gives you information on these five factors so that you, as an informed customer, can make decisions on solar energy that are in your best interests. 1976. 71 p. il. FE 1.2:So 4/3; S/N 041–018–00120–4	1.85
Citizen Action Guide to Energy Conservation: Enormous amounts of energy are wasted in the United States, even though stopping waste is often a simple process that can be acomplished by every citizen. This booklet contains practical suggestions on how you can do something to alleviate the U.S. energy problem. There are tips on conserving energy at home, at work, and in your car, and suggestions on how citizens can combine their efforts and work toward energy conservation at the community level. The booklet gives the name and address of the State contact for energy information in every State. 1973. 64 p. il. Pr 37.8:En 8/C 49/3: S/N 040–000–00300–2	1, 75
Coal Combustion: This publication reports on the technology that must be developed in order to revive coal as a major source of our energy supply. A number of research topics relevant to the production and use of coal are discussed, and a series of findings and conclusions are made. 1977. 59 p. il. Y 4.Sci 2:94–2/yy; S/N 052–070–04092–1	1.80
Coal Mining: This booklet deals with the origin, description, mining, processing, transportation, and use of coal. It is designed to acquaint the reader with a broad knowledge of one of America's chief energy resources. 1975. 34 p.il. I 69.8/2:1; S/N 024–019–00011–0	.50
Coal Resources of the United States, January 1, 1974: This book analyzes the future of coal in America, and gives the benefits we can expect to derive from its use. 1975. 131 p. il. I 19.3:1412; S/N 024–901–02703–8	1.60
Concerning Energy Resources, Message From the President of the United States Concerning Energy Resources. 1973. 24 p. 93–1:H.doc. 85; S/N 052–071–00341–0	.35
Congress and the Nation's Environment, Energy and Natural Resources Actions of the 94th Congress. 1977. 1692 p. Y 4.In 8/13:95–5; S/N 052–070–03919–1	14.00
Conservation and Efficient Use of Energy, Hearings Before the Subcommittee of the House Committee on Government Operations, House, 93d Cong., 1st Sess., May 1–2, 1973. 1973. 132 p. Y 4.C 74/7:En 2; S/N 052–070–01888–7	1.20
Report to Above. 1974. 292 p. 93–2:H.Rept. 1634; S/N 052–071–00428–9	2.60

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[1] Subject bibliography, compiled by the U.S. Government Printing Office, available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Converting Solar Energy Into Electricity: A Major Breakthrough? Hearing Before the Subcommittee on Conservation, Energy, and Natural Resources of the House Committee on Government Operations, June 11, 1976. Discusses the potential and particular advantages of a recently patented invention that converts heat or solar energy into electricity. 1976. 38 p. il. Y 4.G 74/7:So. 4; S/N 052-070-03525-1	$0.55
Current Energy Shortages, Oversight Series: All missing parts are "Out of Print."	
Pt. 1, Conflicting Information on Fuel Shortages, Dec. 14, 1973. 1974. 111 p. il. Y 4.G 74/6:En 2/pt. 1; S/N 052-070-02193-4	1.10
Pt. 2, Major Oil Companies, Jan. 21, 1974. 1974. p. 113–275, il. Y 4.G 74/6:En 2/pt. 2; S/N 052-070-02275-2	1.50
Pt. 3, Major Oil Companies, Jan. 22, 1974. 1974. p. 277–451, il. Y 4.G 74/6:En 2/pt. 3; S/N 052-070-02308-2	1.60
Pt. 4, Major Oil Companies, Jan. 23, 1974. 1974. p. 453–593, il. Y 4.G 74/6:En 2/pt. 4; S/N 052-070-02310-4	1.40
Pt. 7. Oil Brokers, Apr. 4 and 10, 1974. 1974. p. 787–880, il. Y 4.G 74/6: En 2/pt. 7; S/N 052-070-02347-3	1.10
Pt. 8, Cutoff of Petroleum Products to U.S. Military Forces, Apr. 22, 1974. p. 881–984, il. Y 4.G 74/6:En 2/pt.8; S/N 052-070-02393-7	1.15
The Data Base: The Potential for Energy Conservation in Nine Selected Industries. A well-research study that provides basic data on energy consumption in industry, and identifies opportunities for energy conservation. These opportunities are given a cost and policy analysis to determine how they can best be turned into energy savings:	
Alluminum. (Out of print)	
Cement. 1975. 122 p. il. FE 1.22:11; S/N 041-018-00063-1	1.90
Copper. 1975. 127 p. il. FE 1.22:12; S/N 041-018-00061-5	1.90
Energy Management Case Histories. 1975. 15 p. FE 1.22:1A; S/N 041-018-00062-3	.70
Glass. 1975. 139 p. il. FE 1.22:15; S/N 041-018-000691	1.95
Petroleum Refining. 1975. 388 p. il. FE 1.22:10; S/N 041-018-00065-8	4.40
Selected Paper Products. 1975. 160 p. il. FE 1.22:16; S/N 041-018-00070-4	2.25
Selected Plastics. 1975. 144 p. il. FE 1.22:9; S/N 041-018-00064-0	2.80
Steel. 1975. 144 p. il. FE 1.22:14; S/N 041-018-00068-2	2.05
Styrene Butadiene Rubber. 1975. 133 p. il. FE 1.22:17; S/N 041-018-00071-2	2.00
Energy Conservation and Conversion Act of 1975. Hearings Before the Committee on Finance, Senate, 94th Cong., 1st Sess., On H.R. 6860, An Act to Provide a Comprehensive National Energy Conservation and Conversation Program:	
Pt. 1, July 10–14, 1975. 1975. 459 p. il. Y 4.F 49:En 2/8/975/pt.1; S/N 052-070-03027-5	**3.95**
Pt. 2, July 15–18, 1975. 1975. 542 p. il. Y 4.F 49:En 2/8/975/pt.2; S/N 052-070-03135-2	4.60
Economic and Social Costs of Coal and Nuclear Electric Generation: A Framework for Assessment and Illustrative Calculations for the Coal and Nuclear Fuel Cycles. 1976. 127 p. il. NS 1.2:C 63; S/N 038-000-00293-7	2.05
Economic Evaluation of a Process to Separate Raw Urban Refuse Into its Metal, Mineral, and Energy Components. 1977. 25 p. il. I 28.27:8732; S/N 024-004-01902-6	.75
The Economics of Solar Home Heating: A 1976 study prepared for the Joint Economic Committee, analyzing the extent to which solar energy can be economically substituted for more conventional residential heating and hot water systems. The analysis is done on a State-by-State basis, and covers the period 1976–1990. 1977. 86 p. il. Y 4.Ec 7:So 4, S/N 052-070-03968-0	1.35
Economics of the President's Proposed Energy Policies. Hearings Before the Joint Economic Committee, Congress, 95th Cong., 1st Sess., May 20 and 25, 1977. 1978. 177 p. il. Y 4.Ec 7:En 2/15; S/N 052-070-04473-0	2.75

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Electric Energy Systems Program: Linking Sources and Uses: This document describes the Electric Energy Systems Division of the Energy Research and Development Administration, and its role and program for electric energy system R&D. 1977. 27 p. il. ER 1.11:ERDA 77-26; S/N 060-000-00059-0	$1.40
Emergency Workshop on Energy Conservation in Buildings. 1975. 26 p. C 13.46:789-1; S/N 003-003-01439-7	.80
Energy Alternatives, A Comparative Analysis. 1975. 600 p. il. PeEx 14.2: En 2; S/N 041-011-00025-4	9.00
Energy Conservation. Hearings Before the Joint Economic Committee, Subcommittee on Energy, Congress, 94th Cong., 2d Sess., Feb. 2, 3, and 24, and Apr. 13, 1976. 1977. 293 p. Y 4.Ec 7:En 2/3/976; S/N 052-070-03985-0	2.70
Energy Conservation Handbook for Light Industries and Commercial Buildings. 1974. 16 p. il. C 1.8/3:En 2; S/N 003-000-00431-7	.35
Energy Conservation in Buildings, Hearings Before the Government Operations Committee, House, 94th Cong., 2d Sess., July 27-23, 1976. 1976. 323 p. Y 4.G 74/7:En 2/6; S/N 052-070-03802-1	2.90
Energy Conservation in the Food Industry. A Bibliography: An annotated list of publications on how to conserve energy in various sectors of the food system. Includes books for food wholesalers, retailers, manufacturers, and even some for the cooking public. 1976. 73 p. il. FE 1.23: En 2;S/N 041-018-00110-7	1.40
Energy Conservation Program Guide for Industry and Commerce: This is an important guide for those in industry and commerce who are responsible for the use of energy in intermediate to small sized firms. It discusses engineering data and factors; financial evaluation procedures; safety, health, and pollution considerations; and much more. It also provides a list of persons and organizations to contact for assistance. 1974. 206 p. il. C 13.11:115; S/N 003-003-01323-4	2.90
Supplement 1 to Above: Provides more ideas and suggestions, and includes a revised explanation of how to start an energy conservation program, an expanded checklist of energy conservation opportunities, and other additions and revisions to the basic guide. 1975. 96 p. il., looseleaf. C 13.11:115/supp.1; S/N 003-003-01582-2	2,25
Energy Conservation Through Effective Energy Utilization: The proceedings of a 1973 conference held at New England College, Henniker, New Hampshire. The conference focused on ways to utilize thermal energy more effectively. 1976. 261 p. il. C 13.10:403; S/N 003-003-01638-1	3.30
Energy Effective Windows: Proceeding of a Joint DOE (ERDA), NBS Conference, Round Table on Energy Effective Windows Held in Washington, D.C., Apr. 13, 1977. 1978. 53 p. il. C 13.10:512; S/N 003-003-01929-1	2.20
Energy From Coal, A State-of-the-Art Review. 1976. 110 p. il. ER 1.11: ERDA 76-67; S/N 052-010-00489-1	2.05
Energy in Solid Waste: This book reveals the amount of energy in our garbage, trash, and roadside litter that is now being wastefully burned, buried, dumped in the ocean, or thrown indiscriminately across our landscape. It points out how citizens, individually and collectively, can reduce this waste at home, work, and at play, and how they can help in the recovery, recycling, and reuse of the resources now being squandered. The book also makes several recommendations on how the Federal Government can lead the way in fostering such actions. 1974. 40 p. il. Pr 37.8:En 8/En 2/2 S/N 040-000-00319-3	1.25
Energy Management Checklist for the Home. 1975. 7 p. A 1.68:1118; S/N 001-000-03440-5	.35
The Energy Outlook for the 1980's. A Study. This booklet looks into the prospects for developing the energy resources of the United States, providing an overview of ways in which we can increase our output of energy in the years ahead. Promising resources that are individually discussed include coal, offshore production of oil and gas, Alaskan oil and gas, oil shale deposits, nuclear energy, and Canadian tar sands. A concluding review of noncompetitive practices in the petroleum industry is also included. 1973. 39 p. Y 4.Ec 7:En 2/4; S/N 052-070-02113-6	.65

Energy Policy and Conservation Act: An act to increase domestic energy supplies and availability; to restrain energy demand; to prepare for energy emergencies, and for other purposes. Approved Dec. 22, 1975. 99 p. GS 4.110:94/163; S/N 022-003-91101-4	$1.70
Energy Recovery From Waste: Solid Waste as Supplementary Fuel in Power Plant Boilers. 1973. 24 p. il. EP 1.17:36 D 11; S/N 055-002-00116-5	.45
Energy Statistics: Current information and statistics relevant to the formulation of our national energy policy. The data deals with various energy resources (petroleum, natural gas, coal, etc.), consumption trends, production, supply, prices, and imports. 1975. 45 p. il. Y 4.F 49:En 2/7; S/N 052-070-03005-4	.80
Energy Use and Climate: Possible Effects of Using Solar Energy Instead of "Stored" Energy. A brief study of the possible effects on worldwide climate of using solar energy instead of "stored" energy (such as fossil and nuclear fuel) to meet future energy needs. 1975. 53 p. il. NS 1.2:En 2/5; S/N 038-000-00240-6	1.35
Federal Preparedness to Deal With the United States Natural Gas Shortage Emergency, Hearings Before the Committee on Government Operations, House. 94th Cong., 1st Sess., June 12 and 26, 1975. 1975. 851 p. il. Y 4.G 74/7:G 21; S/N 052-070-03083-6	6.70
Final Report: Oil and Gas Resources, Reserves, and Productive Capacities. This report, submitted annually by the Federal Energy Administration to the President and Congress, analyzes and estimates America's potential petroleum resources for present and future utilization. Volume one discusses final reserve and productive capacity estimates, and volume two provides summaries of engineering analyses of major domestic oil and gas fields:	
Vol. 1. 1976. 80 p. FE 1.2:Oi 5/3/v.1; S/N 041-018-00093-3	1.80
Vol. 2. 1976. 160 p. FE 1.2:Oi 5/3/v.2; S/N 041-018-00094-1	2.70
Gasoline and Fuel Oil Shortage, Hearings Before the Subcommittee on Consumer Economics of the Joint Economic Committee, 93d Cong., 1st Sess., May 1–June 2, 1973: Such crucial matters as gasoline distribution and pricing, oil supply and demand, and related energy concerns are examined. 1973. 290 p. il. Y 4.Ec 7:G 21/2; S/N 052-070-01990-9	2.00
Gasoline Distribution, Hearings Before the Joint Economic Committee, Subcommittee on Consumer Economics, 93d Cong., 2d Sess., Mar. 12 and 14, 1974. 1974. 138 p. il. Y 4.Ec 7:G21/3; S/N 052-070-02429-1	1.30
Geothermal Energy, A National Proposal for Geothermal Resources Research. 1976. 95 p. NS 1.2:G 29; S/N 038-000-00163-9	1.70
A Guide to Energy Conservation for:	
Food Service. 1977. 74 p. il., chart. FE 1.8:F 73; S/N 041-018-00127-1	2.25
Grocery Stores. 1977. 40 p. il., chart in pocket FE 1.8:G 89; S/N 041-018-00133-6	1.90
A Guide to Reducing Energy Use Budget Costs. 1977. 93 p. il. E 1.8:B 85; S/N 061-000-00003-8	3.00
Guidelines for Saving Energy In Existing Buildings: Engineers, Architects, and Operators Manual: This manual describes specific ways energy can be saved in the fields of heating, ventilation, cooling, domestic hot water, commercial refrigeration, lighting, and power. A bibliography, selected references, and specific examples of energy conservation are also included. 1975. 448 p. il. FE 1.22:21; S/N 041-018-00080-1	5.05
Handling Fuel and Fuel Problem: An Energy Handbook for Small Businesses. 1975. 16 p. FE 1.8:Sm 4/975; S/N 041-018-00072-1	.35
Home Energy Savers' Workbook: This workbook tells you how to identify ways to make your home more energy-efficient and compute the savings you can expect to realize from each conservation measure. 1977. 29 p. il. FE 1.2:H 75/977; S/N 041-[illegible]-00116-6	.50
In the Bank . . . Or Up the Chimney? Dollars and Cents Guide to Energy-Saving Home Improvements. The most complete and up-to-date collection of money-saving energy information ever produced by the Government for homeowners. The book takes you on a pictorial journey to virtually every corner of your home including some you didn't know could be improved. It shows you how to determine where you can conserve energy, gives you an accurate dollar estimate of how much it's going to cost, and then shows you how to do it. Rev. 1977. 76 p. il. HH 1.6/3:En 2/3/977; S/N 023-000-00411-9	1.70

Industrial Energy Conservation, Hearings Before the Joint Economic Committee, Subcommittee on Energy, Congress, 95th Cong., 1st Sess., July 28, 1977. 1978. 39 p. Y 4.Ec 7:En 2/16; S/N 052-070-04500-1	$1.50
Industry Efforts in Energy Conservation. 1974. 285 p. Y 4. C 73/2:En 2/3; S/N 052-070-02586-7	3.50
Interdisciplinary Student Teacher Materials in Energy, the Environment, and the Economy:	
How a Bill Becomes a Law to Conserve Energy, Grades 9, 11, and 12. 1977. 115 p. il. E 1.9:B 49; S/N 061-000-00080-1	2.75
United States Policy, Which Direction? Grades 11-12, Draft. 1978. 89 p. il. E 1.9:P 75/draft; S/N 061-000-00078-0	2.50
Lighting and Thermal Operations, Energy Conservation Principles Applied to Office Lighting: This book studies energy conservation principles as they apply to office lighting. It includes the relationship of illumination to visual performance and lighting energy to heating and cooling energy, and provides a summary of new techniques and equipment for energy conservation. 1975. 273 p il. FE 1.22:18; S/N 041-018-00084-4	3.55
Liquified Natural Gas: Safety, Siting and Policy Concerns. 1978. 147 p. il. Y 4.C 73/7:G 21; S/N 052-070-04566-3	2.50
Making the Most of Your Energy Dollars in Home Heating and Cooling: This booklet tells you, for your climate and the type of energy used to heat and cool your house, what combination of energy conservation improvements to invest in to get the largest long run net savings in your heating and cooling bills. It also gives you general information you should have before you invest in any energy conservation improvements. This includes tips about storm windows and doors, weather stripping, moisture control, and insulating attics, walls and floors. 1975. 17 p. il. C 13.53:8; S/N 003-003-01446-0	.70
Material Shortages, Selected Readings on Energy Self-Sufficiency and Controlled Materials Plan. 1974. 256 p. Y 4.G 74/6:En 2/7; S/N 052-070-02475-5	2.50
Multinational Oil Companies and OPEC. Implications for U.S. Policy, Hearings Before the Joint Economic Committee, Subcommittee on Energy, Congress, 94th Cong., 2d Sess., June 2-3 and 8, 1976. 1977. 337 p. il. Y 4.Ec 7:Oi 5/10; S/N 052-070-03980-9	3.00
National Energy Act: This is the text of President Carter's proposed National Energy Act, which he transmitted to Congress on Apr. 29, 1977, and which became the subject of heated debate in Congress and throughout the nation. 1977. 283 p. 95-1:H.doc. 138; S/N 052-071-00521-8	4.00
National Energy Plan: Presents President Carter's Energy Plan submitted to Congress on Apr. 20, 1977. 1977. 103 p. il. PrEx 1.2:En 2/2; S/N 040-000-00380-1	2.60
The Natural Gas Story: This publication traces the history of the natural gas industry, the development of a growing shortage of natural gas supplies, and the potential solutions which can be undertaken by the industry and by the Federal government to assure adequate supplies of gas to meet the Nation's needs. 1975. 18 p. il. FE 1.2:G 21; S/N 041-018-00089-5	.50
Oil Shale, A Potential Source of Energy. 1972, reprinted 1977. 16 p. il. I 19.2:Oi 5/4/972; S/N 024-001-02204-4	.90
Our Prodigal Sun: Provides a brief introduction to the life and the anticipated eventual death of the sun, discusses the sun as the possible source of all future forms of energy, and talks about the problems in obtaining pure solar energy. 1974. 14 p. il. NAS 1.19:118; S/N 033-000-00569-5	.35
Petroleum Storage, Alternative Programs and Their Implications for the Federal Budget. 1976. 67 p. il. Y 10.9:14; S/N 052-070-03718-1	1.25
Polar Energy Resources Potential, A Report. 1976. 178 p. il. Y 4.Sci. 2:94-2/zz; S/N 052-070-03915-9	2.50
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